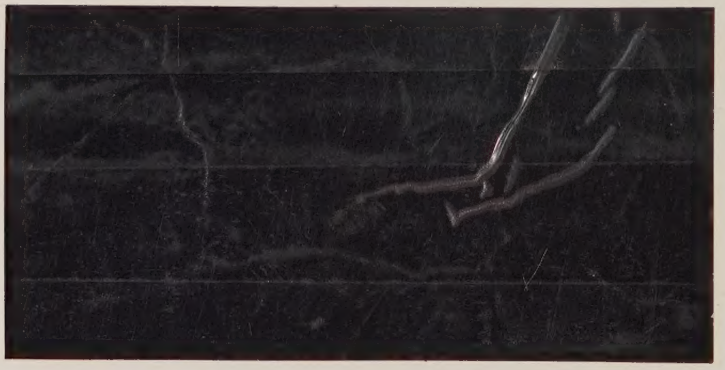
DRANETZ



LAST ONE!

Customer gets a copy

Cello Series
Return this to the floor

Cello Series
LAST ONE!

Dranetz

Cello Series
qp-vol 1

TM-03140

MP MASTER
MA22631

WARNING

Because of possible shock or fire hazards, connection to this instrument should be performed in compliance with the National Electrical Code (ANSI C1) and/or any other requirements which may be applicable to the user.

Installation, operation, and maintenance should be performed only by qualified personnel.

Revised 15 January 1982

TM-103140 I

OPERATOR'S MANUAL

VOLUME 1

DC/AC VOLTAGE DISTURBANCE ANALYZER

SERIES 616

NOTE

Refer to Volume 2 of TM-103140 for maintenance data. To obtain Volume 2, execute and return the 'Application to Become a Registered Recipient of a D.E.L. Proprietary Manual.' This form is included at the end of this volume.

This equipment is manufactured under U. S. Patent Number 3,549,874 —Dranetz Eng. Labs., Inc. 23207

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870506

DRANETZ

DRANETZ ENGINEERING LABORATORIES, INCORPORATED
1000 New Durham Road, CN-91, Edison, N.J. 08818

STATEMENT OF WARRANTY

ALL PRODUCTS OF DRANETZ ENG. LABS., INC. ARE WARRANTED TO THE ORIGINAL PURCHASER AGAINST DEFECTIVE MATERIAL AND WORKMANSHIP FOR A PERIOD OF ONE YEAR FROM THE DATE OF DELIVERY. DRANETZ WILL REPAIR OR REPLACE, AT ITS OPTION, ALL DEFECTIVE EQUIPMENT RETURNED, FREIGHT PREPAID, DURING THE WARRANTY PERIOD, WITHOUT CHARGE FOR REPAIR, PROVIDED THERE IS NO EVIDENCE THAT THE EQUIPMENT HAS BEEN MISHANDLED OR ABUSED.

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SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

This volume of the manual provides operating instructions for the Series 616 DC/AC Voltage Disturbance Analyzer (hereinafter referred to as the Analyzer), manufactured by Dranetz Engineering Laboratories, Incorporated, Edison, New Jersey. Volume 2 contains the maintenance instructions for the Analyzer. The Dranetz Series 616 consists of the 616A, 616B, and 616C. All three versions are identical in theory and operation, differing only in monitor input specifications. This section describes the purpose, application and technical characteristics of the Analyzer. (See figure 1-1.)

1.2 PURPOSE

The Model 616 is an electronic solid-state portable instrument designed to monitor both short and long term voltage disturbances. Capable of continuous unattended operation, the computer-controlled unit stores, analyzes, classifies, and prints out quantitative and qualitative disturbance data. Accompanying the data is a printout of time derived from a highly accurate crystal controlled 24-hour clock.

The Model 616A monitors one isolated AC channel on one range from 40 VRMS to 250 VRMS and two isolated DC channels on one range from 4 VDC to 25 VDC. For the Model 616B, the range of the AC channel is 80 VRMS to 500 VRMS and for each DC channel it is 8 VDC to 50 VDC. On the Model 616C, the range of the AC channel is also 80 VRMS to 500 VRMS, but for each of the DC channels it ranges from 12 VDC to 75 VDC.

The Analyzer classifies all noise disturbances into three categories; slow average, sag/surge, or impulse. The threshold value of each type of disturbance, above which detection and printout occurs, is operator selectable. Except for an automatic summary printout at the end of each day, printout normally occurs only when disturbances occur (or upon operator demand). Whenever a disturbance threshold is exceeded, a relay closure on the rear panel occurs. In an alternate mode, only a disturbance data summary printout occurs at the end of each day. These features permit long term unattended operation.

Figure 1-1. Series 616 DC/AC Voltage Disturbance Analyzer

1.3 APPLICATIONS

The unique ability of the Analyzer to monitor AC and DC simultaneously makes the instrument ideal for analytical evaluation of power-conversion equipment. The Analyzer is especially aimed at line-sensitive equipment used in such crucial areas as computation, process control, communications, and medicine. Typical applications are described below.

1.3.1 Field Troubleshooting. It is not sufficient merely to identify disturbances on the AC input to a power supply. Rather, it is essential to prove that the AC input disturbance caused a disturbance in the DC output and, therefore, contributed to an equipment malfunction. The Analyzer provides this correlation.

1.3.2 Testing Power Conditioning Equipment. Measure the effect of transients, dropouts, and other disturbances on the proper internal functioning of voltage regulators and UPS systems.

1.3.3 Monitoring Battery Voltages. Detect troublesome disturbances on the DC battery voltages used in electric utility substations and in telephone central offices.

1.3.4 Power Supply Life Testing. Determine whether failures or "out-of-spec" performance are caused by disturbances on the AC input to the life test rack.

1.3.5 Transient Throughput Analysis. When designing power supplies, measure the response of DC output levels to transient disturbances on the AC input.

1.3.6 Output/Input and Output/Input Interaction Analysis. Measure the effects of output load variations on other DC output levels and the AC input voltage.

1.3.7 DC Current Monitoring. Using suitable current probes, measure and record disturbances in current.

1.4 EQUIPMENT CHARACTERISTICS

The characteristics of the Analyzer are specifically designed to meet the requirements of power system applications. The portable instrument is small and light-weight, equipped with a carrying handle and rubber feet, and is capable of fitting under commercial airline seats. A rugged aluminum case, combined with sturdy internal construction, prevents damage to the unit during transport. The Analyzer is entirely self contained, requiring no ancillary equipment. As shown in figure 1-1, all controls and indicators are conveniently grouped around the thermal printer. Printout on the 2-1/4"

wide paper is in plain language, in large easy-to-read print. Printer operation is switched to a paper conserve mode when the internal paper supply is low. The detailed specifications of the Analyzer are presented in Table 1-1.

TABLE 1-1. SERIES 616 ANALYZER SPECIFICATIONS

MODELS AVAILABLE

616A Single AC channel and two DC channels

MAX INPUT	NOMINAL INPUT*	MIN INPUT	MAX IMPULSE**	INPUT IMPEDANCE
250V AC	115V AC	40V AC	1000V	100 Kilohms
±25V DC	-	±3.2V DC	10V	10 Kilohms

616B Single AC channel and two DC channels

MAX INPUT	NOMINAL INPUT	MIN INPUT	MAX IMPULSE	INPUT IMPEDANCE
500V AC	230V AC	80V AC	2000V	200 Kilohms
±50V DC	-	±6.4V DC	20V	20 Kilohms

616C Single AC channel and two DC channels

MAX INPUT	NOMINAL INPUT	MIN INPUT	MAX IMPULSE	INPUT IMPEDANCE
500V AC	230V AC	80V AC	2000V	200 Kilohms
±75V DC	-	±9.6V DC	30V	30 Kilohms

*Monitoring range for AC channel Sag/Surge and Slow Average is ±50% of nominal value except where otherwise noted.

**Maximum voltage for impulse with effective duty cycle less than 1%.

PRINTOUT DATA TYPES:

Slow-Averaging-Slow steady-state changes in monitored line voltage (approximate settling time: 10 seconds).

Sag/Surge- AC Channel: Cycle to cycle changes in voltage inputs.
DC Channel: Interval to interval changes in voltage input, where an interval is defined as the time = 1/f of the AC channel input (f=freq).

Impulse- Peak reading of impulse (after filtering out steady state voltage waveform) having duration between 0.5 and 800 useconds.

TABLE 1-1. SERIES 616 ANALYZER SPECIFICATIONS (cont)

TIME CLOCK:

Controlled by internal crystal oscillator. Crystal stability ±25 PPM (approx. ±2 seconds/day). Clock can be set to within 1 second with front panel CLOCK pushbuttons. Key switch prevents alteration of clock setting during normal instrument operation.

AUDIBLE ALARM:

Built-in audible alarm which may be disabled or placed in 1 second signal duration mode by ALARM pushbutton.

THRESHOLD VOLTAGE (SWITCH SELECTABLE):

Model	Disturbance/ Printout Desig.	AC (volts rms)	DC (volts)
616A	Slow Average AVG+ or AVG-	3, 5, 10, 15	.3, .5, 1.0, 1.5
	Sag/Surge (SAG or SURGE)	3, 5, 10, 15	.3, .5, 1.0, 1.5
	Impulse (Peak, without carrier) (IMPULSE)	50, 100, 200, 400	.5, 1.0, 2.0, 4.0
616B	Slow Average AVG+ or AVG-	6, 10, 20, 30	.6, 1.0, 2.0, 3.0
	Sag/Surge (SAG or SURGE)	6, 10, 20, 30	.6, 1.0, 2.0, 3.0
	Impulse (Peak, without carrier) (IMPULSE)	100, 200, 400, 800	1.0, 2.0, 4.0, 8.0
616C	Slow Average AVG+ or AVG-	6, 10, 20, 30	.9, 1.5, 3.0, 4.5
	Sag/Surge (SAG or SURGE)	6, 10, 20, 30	.9, 1.5, 3.0, 4.5
	Impulse (Peak without carrier) (IMPULSE)	100, 200, 400, 800	1.5, 3.0, 6.0, 12.0

TABLE 1-1. SERIES 616 ANALYZER SPECIFICATIONS (cont)

ACCURACY (AC INPUT CHANNEL):

Slow Average:	at 60 Hz, ±1% of reading ±1% of nominal input (sine wave inputs)
Sag/Surge:	at 60 Hz, ±1% of reading ±1% of nominal input (sine wave inputs)
Impulse:	±5% of reading ±1% of maximum impulse, calibrated with a positive going, 10 usec., half sinewave impulse. Typical single impulse frequency response is ±1 dB for impulse widths from 10 to 50 usec and ±6 dB from 0.5 to 800 usec, measured with half-sinewave inputs.

ACCURACY (DC INPUT CHANNEL):

Slow Average:	±1% of reading ±.5% of maximum input
Sag/Surge:	±1% of reading ±.5% of maximum input
Impulse:	±5% of reading ±1% of maximum impulse, calibrated with a positive going, 10 usec., half sinewave impulse. Typical single impulse frequency response is ±1 dB for impulse widths from 10 to 50 usec and ±6 dB from 0.5 to 800 usec, measured with half-sinewave inputs.

OPERATION FROM DISTURBED LINES:

Operates properly with disturbances on its own power line over specified measuring ranges of impulses, sags and surges[†]. Also operates properly during line interruptions of up to approximately 0.5 sec in nominal line voltage. Unit switches to internal batteries when line interruption exceeds 0.5 sec. At this time, POWER OFF message and time are printed; clock and memories are maintained for up to 4 hours. After 10 full seconds of restored power, POWER ON message and time are printed, and instrument shifts back to normal operation.

[†]Surges limited to 140 volts RMS

STEADY STATE POWER REQUIREMENTS:

90 to 140 volts, 45-65 HZ, single phase (120-170 Volts, DC), 1.0 amperes maximum

TABLE 1-1. SERIES 616 ANALYZER SPECIFICATIONS (cont)

ALARM RELAY CONTACT RATING:

24V AC or DC at 100 mA max, noninductive.

DIMENSIONS:

11"H x 8"W x 9-1/2"D
(28 cm H x 18 cm W x 24 cm D)

NOTE: An optional 19" rack mount with dust covers is also available.

WEIGHT:

Approximately 20 lbs typ. (9 kg)
Shipping weight - 25 lbs typ. (11.3 kg)

1.5 OPTIONS AND ACCESSORIES

1.5.1 Option 101. Under/over frequency monitoring on input channel A, with selectable thresholds of ±1/2, 1, and 2 Hz; ±0.25 Hz accuracy. The frequency is monitored over 1-second sampling periods. Printout indication of frequency changes exceeding selected threshold is "FREQ+" or "FREQ-".

1.5.2 Option 102. Power operation either from 180 to 280V RMS, 45 to 65 Hz, single phase, or from 90 to 140V RMS, 45 to 65 Hz, single phase (switch-selectable).

1.5.3 Option 104. Adds to the basic 616 an additional optically isolated, 2-terminal signal-input channel that accepts a 5 to 15V DC external signal. Each application of such an external signal generates a time-mark entry and identifying symbol ("#" followed by the time in hours, minutes, and seconds) on the record printout. Can be used to enter, manually or automatically, a record of occurrences of any external event (such as an equipment malfunction) for use in subsequent analysis.

1.5.4 Option 105. Provides the interface that permits Channel A of Model 616 to communicate with external adapter devices such as 606-PA-600X. For operation with these adapters, refer to TM-103161. (For instructions on cable connections, see paragraph 2.13.)

NOTE: Use only Channel A of the Model 616 and 606-PA-600X Adapter for Option 105. Do not connect Channels B and C.

1.5.5 Option 106. RS232C data output. (See instructions in paragraph 2.14.)

1.5.6 Model 604A Disturbance Simulator. Portable, calibrated disturbance simulator that produces sags, surges, impulses, and slow variations in RMS voltage for rapid performance check of the Model 616 AC channel in the field or test laboratory.

1.5.7 Model 604A-PA-1001 Disturbance Simulator Adaptor. A compact assembly and connecting cable compatible with the Model 604A. The combination of this adaptor and the Model 604A produces sags, surges, impulses and slow variations for both DC channels and the AC channel of the 616.

1.5.8 Model K103 Test Kit. Contains the Model 604 and a set of programmed memories for exercising the computer to facilitate troubleshooting and maintenance. Card puller and extender card are also included.

1.5.9 Model 910 Uninterruptible Power Supply: Designed to operate Series 616 continuously and to carry it through complete source-power interruptions of up to 2 hours without degrading operation. Operates properly with disturbances on its own power line over specified measuring ranges of impulses, sags, and surges.

1.5.10 Printer Paper (P/N 102714): Thermal paper approximately 140 feet by 2-1/4" rolls (2.5 inch diameter). Three spare rolls supplied with instrument.

1.6 STANDARD ACCESSORIES (SHIPPED WITH ALL UNITS)

1.6.1 115 Volt line cord

1.6.2 Three (3) rolls of printer paper P/N 102714

1.6.3 Instruction Manual TM-103140

1.7 FACTORY REPAIR

When factory repair is desired, proceed as follows:

1. Contact the Dranetz Engineering Customer Service Department and obtain an Authorization Number.

2. Fill out the Repair/Service Order enclosed in this manual and ship it with the equipment to the Customer Service Department.

CUSTOMER SERVICE DEPT.
DRANETZ ENG. LABS., INC.
1000 New Durham Road, CN-91
Edison, New Jersey 08818

REPAIR/SERVICE ORDER

TEL. (201) 287-3680
(201) 287-2535
TWX: (710) 997-9553
CABLE: DRANETZ

NOTE: THIS COMPLETED FORM MUST ACCOMPANY RETURNED EQUIPMENT

CUSTOMER SHIPPING & BILLING INFORMATION

CUSTOMER P. O. # _____ P. O. DATE _____

SHIP TO: _____ INVOICE TO: _____

In Continental U. S., material will be returned by Dranetz to you by UPS, UPS Blue or other carrier chosen by Dranetz unless otherwise designated.

EQUIPMENT BEING RETURNED

Date of Original Purchase: _____ Original P. O. # _____

Model No. _____ S/N _____

Model No. _____ S/N _____

Ancillary equipment also being returned (If you neglect this, these items may not be returned to you).

☐ Power & Other Cables _____ ☐ Instr. Book _____

☐ Plug-ins (incl. S/N) _____ ☐ Connectors _____

☐ Other _____

RETURN AUTHORIZATION

Have you discussed the problem with Dranetz Sales or Service personnel?

Dranetz Return Authorization # _____

By: _____

If so, with whom _____ Date: _____

Whom should the Dranetz Customer Service Dept. contact for technical questions?

_____ ( )

NAME (Print) DEPARTMENT TELEPHONE

DESCRIPTION OF PROBLEM

Please be detailed, explicit and complete. Include test data, if this helps to describe the problem.
IMPORTANT: Repairs cannot be made unless this section is completely filled out.
(Attach added sheets if necessary)

_____

_____

_____

_____

CHECK WHERE APPLICABLE: IS MALFUNCTION RELATED TO: Warmup ☐ Temperature ☐

Intermittency ☐ Mechanical Handling ☐ Visual Defects ☐ Grounding ☐ Test Data Attached ☐

INITIATOR OF THIS ORDER

_____

NAME/TITLE SIGNATURE TELEPHONE

(SEE OTHER SIDE FOR INSTRUCTIONS)

IMPORTANT (ENCLOSE THIS ENTIRE FORM WITH EQUIPMENT)

INSTRUCTIONS FOR REPAIR ORDER – DRANETZ ENGINEERING LABS.

IMPORTANT: FOLLOW INSTRUCTIONS & USE THIS FORM. IT IS DESIGNED TO HELP US HELP YOU.

1. Before returning equipment to our factory. call our Customer Service Department, Tel:(201) 287-2535 Give the model No., serial number, and information on the problem.

   A. Our specialists may be able to solve your problem rapidly without equipment return.

   B. If equipment return is needed, you will be supplied with appropriate instructions and authorization information to expedite service.

2. If return is to be made,

   A. Fill out the other side of this form COMPLETELY.

   B. Enclose original of form INSIDE the shipping carton, preferably attached by masking tape to the equipment.

   C. Ship prepaid (including insurance); we will return prepaid unless otherwise advised by you.

   D. IMPORTANT - PACK PROPERLY! SHIPPING DAMAGE WILL BE CHARGED TO YOU!

NOTE:

Statement of Warranty - All products of Dranetz Eng. Labs., Inc. are warranted to the original purchaser against defective material and workmanship for a period of one year from the date of delivery. Dranetz will repair or replace, at its option, all defective equipment returned, freight prepaid, during the warranty period, without charge for repair, provided there is no evidence that the equipment has been mishandled or abused.

FILL OUT OPPOSITE SIDE OF THIS FORM AND RETURN WITH EQUIPMENT.

INSTRUCTIONS FOR REPAIR ORDER – DRANETZ ENGINEERING LABS.

SECTION II

INSTALLATION AND OPERATION

2.1 GENERAL

This section contains the installation and operating procedures for the Analyzer. The functions of all operating controls and indicators are provided and the various printouts produced by the Analyzer are described in detail. Refer to Appendix A for additional disturbance data and printouts.

NOTE

Current Analyzer Models use a new thermal printer assembly (Dranetz P/N 103600), described in the main body of this manual. Information covering an earlier printer assembly (Dranetz P/N 102889) is included for reference in Appendix B.

2.2 UNPACKING

Carefully open upper end (as marked) of shipping carton. All accessories (three rolls of paper, instruction manual, and any optional equipment) are packed in a small compartment at the top of the carton. Remove accessories and packaging material, then lift cardboard insert to expose the Analyzer which is shipped in the upright position. Grasp the carrying handle and pull the instrument straight up and out of the container.

Inspect the unit for possible damage incurred during transit. IF DAMAGE EXISTS, NOTIFY CARRIER AND DRANETZ ENGINEERING LABORATORIES, AND RETAIN SHIPPING CARTONS AND ALL PACKING MATERIAL. DO NOT RETURN UNIT WITHOUT INSTRUCTIONS FROM MANUFACTURER.

2.3 OPERATING CONTROLS AND INDICATORS

The functions of all front panel operating controls and indicators are presented in Table 2-1. All referenced items are shown in figure 2-1.

TABLE 2-1. OPERATING CONTROLS AND INDICATORS

Index No.	Controls or Indicators	Function
1	THRESHOLD VOLTS-SLOW AVG switch	Selects one of four threshold voltage values for slow average disturbances. Upper range is for channel A (AC volts rms) and lower range is for channels B and C (DC volts).

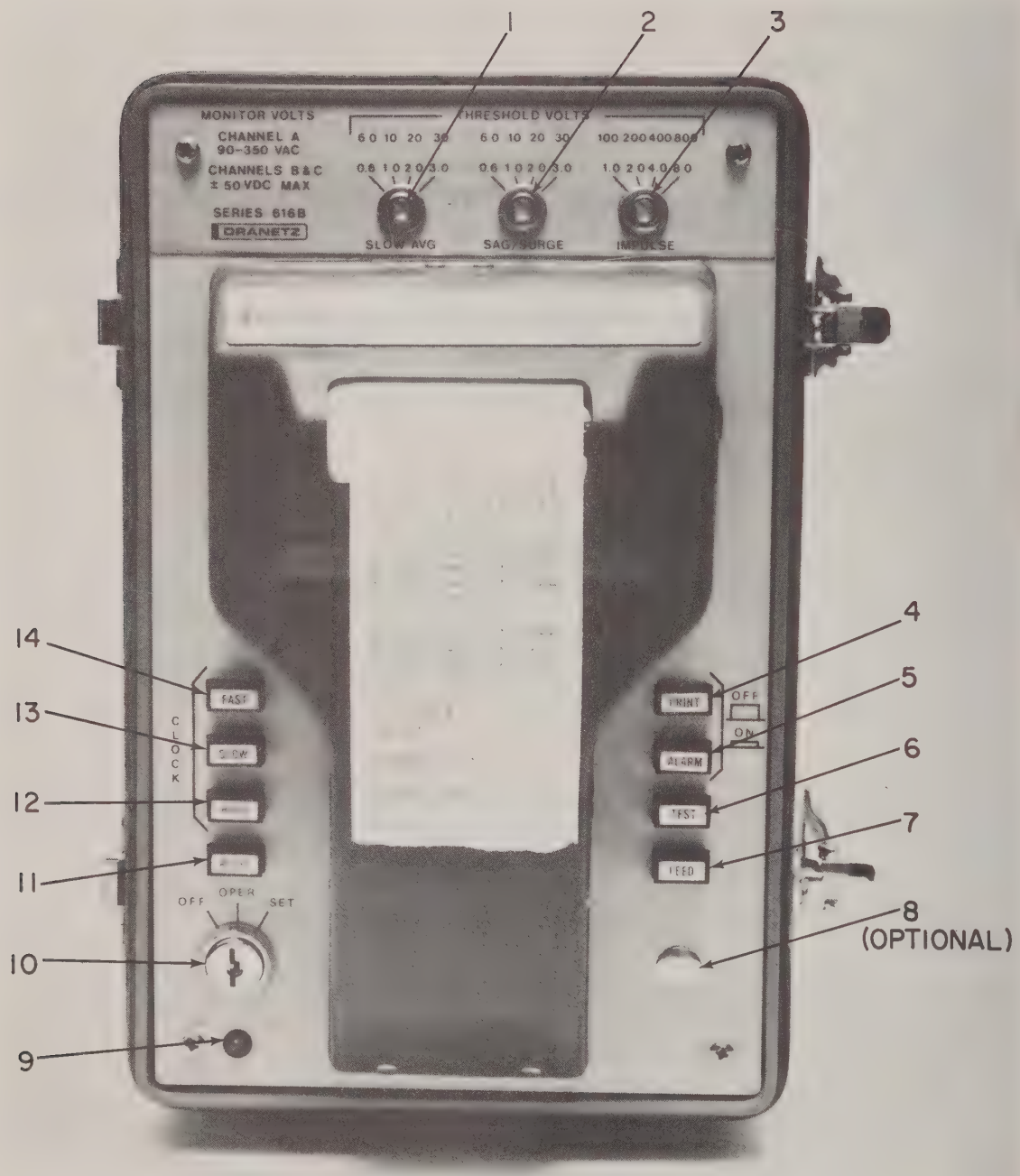


Figure 2-1. Operating Controls and Indicators

TABLE 2-1. OPERATING CONTROLS AND INDICATORS (Cont'd.)

Index No.	Controls or Indicators	Function
2	THRESHOLD VOLTS-SAG/SURGE switch	Selects one of four threshold voltage values for SAG/SURGE disturbances. Ranges are the same as for the SLOW AVG switch.
3	THRESHOLD VOLTS-IMPULSE switch	Selects one of four threshold voltage values for IMPULSE disturbances. Ranges are the same as for the SLOW AVG switch.
4	PRINT pushbutton	When depressed to "in" position, normal printout of disturbance data is enabled. When depressed to "out" position, the unit prints out PRINT OFF and time, and further printout is inhibited unless one of the following occurs: 1. TEST button is depressed. 2. Power is turned off or on. 3. End of day produces daily accumulated summary.
5	ALARM pushbutton	When depressed to "in" position, the alarm circuit is enabled.
6	TEST pushbutton	When depressed, unit prints TEST, followed by daily accumulated summary.
7	FEED pushbutton	When depressed, paper tape advances out of printer.
8	FREQ THRESHOLD switch (optional)	Option 101: Selects one of three frequency threshold values (45-65 Hz operation).

TABLE 2-1. OPERATING CONTROLS AND INDICATORS (Cont'd.)

Index No.	Controls or Indicators	Function
9	LINE-BATT dual LED indicator	Indicates instrument power source; green for line, red for internal battery (standby mode).
10	Key operated mode switch	OFF position: Instrument is off and key is locked. OPER position: Instrument is on, key may be removed, but CLOCK and RESET buttons are inoperative. SET position: Clock and reset circuits are enabled and key is locked.
11	RESET pushbutton	When depressed (mode switch in SET position), unit prints RESET, day count is reset to 00, accumulated summary is printed and all data is cleared from memory. Instrument clock is not affected.
12	CLOCK HOLD pushbutton	When depressed, freezes instrument time at its last value.
13	CLOCK SLOW pushbutton	When depressed, advances instrument time at slow rate (1 min/sec).
14	CLOCK FAST pushbutton	When depressed, advances instrument time at fast rate (1 hr/sec).

2.4 OPERATIONAL DESCRIPTION

2.4.1 Disturbance Measurements

2.4.1A Slow Average. The slow average measurement represents a steady state value based on a 10-second moving average of the monitored voltage. The slow average printout value is always accompanied by time in hours, minutes, and seconds. As an example, the printout

A 100 V AV 16:29:03

indicates that the channel A slow average measured at 16:29:03 was 100 volts RMS. Assume that the SLO AVG switch is set to 5 volts. When any subsequent channel A slow average measurement changes from the above printout by 5 volts (drops to 95 volts or rises to 105 volts), the instrument responds by printing out the time, channel, new voltage and a plus or minus sign to indicate the direction of change from the previous printout. For example the next slow average printout may take the following form

A 095V AVG -

18:05:56

NOTE

Since the paper tape moves downward, the time value is printed first, followed by the average voltage value.

Once a new slow average printout occurs, that value becomes the new reference for the SLO AVG switch setting. Thus, for the example given, the next slow average printout occurs when the measured value drops to 90 volts or rises to 100 volts RMS.

2.4.1B Sag/Surge - Sags and surges are sudden negative or positive changes in the value of the monitored voltage. The Analyzer measures the value of each AC cycle and compares it with the slow averaged steady state value. For the DC channels, the Analyzer measures the time average value for a period equal to that of the channel A cycle. This value is compared to the slow averaged steady state value of that channel. If a single interval measurement is lower, the Analyzer recognizes a SAG; if higher, it recognizes a SURGE. If the change exceeds the threshold setting of the SAG/SURGE switch, the Analyzer prints out time, channel (A, B, or C), value of the most extreme single interval measurement, and the duration in number of cycles. In addition, the reading is identified as a SAG or SURGE. As an example, the printout

0013 CYCLES
B 24.0V SURGE
13:28:21

indicates that a surge to 24V of 13 cycles of the channel A (AC) duration was measured on the channel B input at 13:28:21. Again, it should be noted that SAG and SURGE printouts occur only when the limits set by the SAG/SURGE settings are exceeded.

2.4.1C Impulse. Transient impulses (spikes) having a duration between 0.5 and 800 microseconds are continuously monitored by the Analyzer. The instrument samples each channel of the input line in 2-cycle periods, holding the highest peak value measured (excluding instantaneous AC line voltage or steady state DC voltage). If one or more impulses measured in any 2 cycle interval exceeds the threshold value selected by the IMPULSE switch, the Analyzer prints the time, channel designation, highest peak value measured and the word IMPULSE. As an example, the printout

C 1.44 V IMPULSE
C 1.95 V IMPULSE
17:59:01

indicates that two impulses, one of 1.95 volts peak and another at 1.44 volts peak were measured on the channel C input at 17:59:01.

NOTE

All references to measurements and printouts of line disturbances in the balance of this manual presuppose that the instrument's threshold settings have been exceeded.

2.4.2 Summary Modes

2.4.2A Stored Disturbances. If line disturbances occur during printout, the Analyzer continues to measure them and stores data on up to 15 sequential disturbances in memory. These are printed out in proper sequence when the printer is free.

2.4.2B Short Term Accumulated Count Mode. If the number of disturbances to be stored reaches 16, the internal computer switches to a short term accumulated count mode and stores summarized data. When stable conditions return and after the individual disturbance data stored in memory have been printed out, a short term summary printout of the overflow disturbances is produced for each channel. The following is an example:

C 10.5V AV 18:03:38
B 10.2V AV 18:03:37
IMP 0184V 0012 HTS
SAG 070V 0014 HTS
SUR 102V 0003 HTS
LO AVERAGE 085V
HI AVERAGE 100V
A 100V AV 18:03:32
SHORT TERM ACCUM

This printout, identified as a short term accumulated summary, indicates the following:

(1) RMS value of voltage on channel A is 100 volts, measured at 18:03:32.

(2) Highest slow average voltage that occurred during overflow interval was 100 volts RMS.

(3) Lowest slow average voltage that occurred during overflow interval was 85 volts RMS.

(4) Highest SURGE RMS voltage that was measured is 102 volts; total number of SURGE occurrences during overflow interval was 3.

(5) Lowest SAG RMS voltage that was measured is 70 volts; total number of SAG occurrences during overflow interval was 4.

(6) Highest IMPULSE voltage that was measured is 184 volts peak; total number of impulses during overflow interval was 12.

(7) Voltage on channel B is 10.2 volts, measured at 18:03:37. (No channel B disturbances occurred during overflow interval).

(8) Voltage on channel C is 10.5 volts, measured at 18:03:38. (No channel C disturbances occurred during overflow interval).

2.4.2C Daily Accumulated Count Mode. At the start of each day (time 00:00:01), the Analyzer automatically prints out a summary of the previous day's activity. The following is an example:

C 10.5V AV 00:00:07
B 10.4V AV 00:00:06
IMP 0208V 0004 HTS
SAG 086V 0002 HTS
SUR 124V 0003 HTS
LO AVERAGE 090V
HI AVERAGE 100V
A 100V AV 00:00:01
DAY 22 ACCUM

This printout, identified as the accumulated summary of day 22, indicates the following:

(1) Latest measured value of channel A slow average voltage, at time 00:00:01 (of new day 23) is 100 volts RMS.

(2) Highest measured value of channel A slow average voltage in past 24 hours* was 100 volts RMS.

(3) Lowest measured value of channel A slow average voltage in past 24 hours* was 90 volts RMS.

(4) Highest measured channel A SURGE voltage in past 24 hours* was 124 volts RMS; a total of three SURGE voltages occurred.

(5) Lowest measured channel A SAG voltage in past 24 hours* was 86 volts RMS; a total of two SAG voltages occurred.

(6) The highest measured channel A IMPULSE voltage in past 24 hours* was 208 volts peak; a total of four IMPULSES occurred.

(7) Latest measured value of channel B slow average voltage, at time 00:00:06 is 10.4 volt. (No channel B disturbances occurred.)

(8) Latest measured value of channel C slow average voltage, at time 00:00:07 is 10.5 volt. (No channel C disturbances occurred.)

*Or since reset, if instrument was reset in past 24 hours.

NOTE

At the end of the daily accumulated count, the computer memories are cleared of data (reset) and the day counter is advanced to the next day (day 23 in the above example).

2.4.2D Test Mode. When the TEST pushbutton is depressed, the same information printout described in the Daily Accumulated Count Mode is printed out. In this case, the first line of the printout takes the following form

TEST DAY 22 ACCUM

and since the day has not ended, stored disturbance data is not affected and the day counter is unaffected.

The TEST pushbutton also activates a memory validation test. If the data memory is invalid, the TEST printout is immediately followed by:

C 11.6V AVG+
B 11.5V AVG+
A 115V AVG+
17:22:48
RESET

This printout clears all stored disturbance data and reestablishes the average values indicated. The occurrence of this printout is extremely rare under normal operating conditions.

2.4.2E Reset Mode. When the RESET pushbutton is depressed (with mode switch in SET position) the same information printout described in the Daily Accumulated Count Mode is printed out. The first line of the printout takes the following form:

RESET DAY 22 ACCUM

After this printout, the computer memories are cleared of data (reset) and the day counter is also reset (set to DAY 00). The time clock is unaffected.

2.4.3 Interruptions of Line Power. If the AC or DC line that powers the Analyzer is interrupted, a printout such as the following is produced:

POWER OFF 02:06:43

At this time, the instrument switches to internal batteries which maintain the clock and the data stored in computer memory for up to four hours. No new data is accumulated during power off operation.

Ten seconds after power is restored, a printout such as the following is produced:

POWER ON 02:55:01

NOTE

Actual 'power on' occurred at 02:54:51.

2.5 CONNECTING UNITS WITHOUT OPTION 102 TO POWER SOURCE

For the Model 616, a power source connector separate from the signal terminal strip is provided. (See figure 2-2.) Proceed as follows:

2.5.1 Insert key in key switch on front panel and set switch to OFF position.

2.5.2 Turn off or disconnect the AC or DC power source that is to be used to power Analyzer.

2.5.3 Connect the power cord (90 to 140 volts, 45-65 Hz AC or 120 to 170 volts DC) to the AC receptacle on the rear panel.

2.6 CONNECTING UNITS WITH OPTION 102 TO POWER SOURCE

Option 102 provides the Model 616 with the capability of operating from a 180-280 volt, 47-65 Hz power line as well as from the standard 90-140 volt, 47-65 Hz and 140 volt DC power lines. The optional equipment includes a stepdown autotransformer, a line voltage selector switch, and a means for tapping the autotransformer for high and low input voltage ranges.

Option 102 has no relation to the input(s) being monitored by the Model 616.

2.6.1 Disconnect all power sources from the unit.

2.6.2 Unfasten the two screws and lift the plastic terminal strip cover away from the terminal strip.

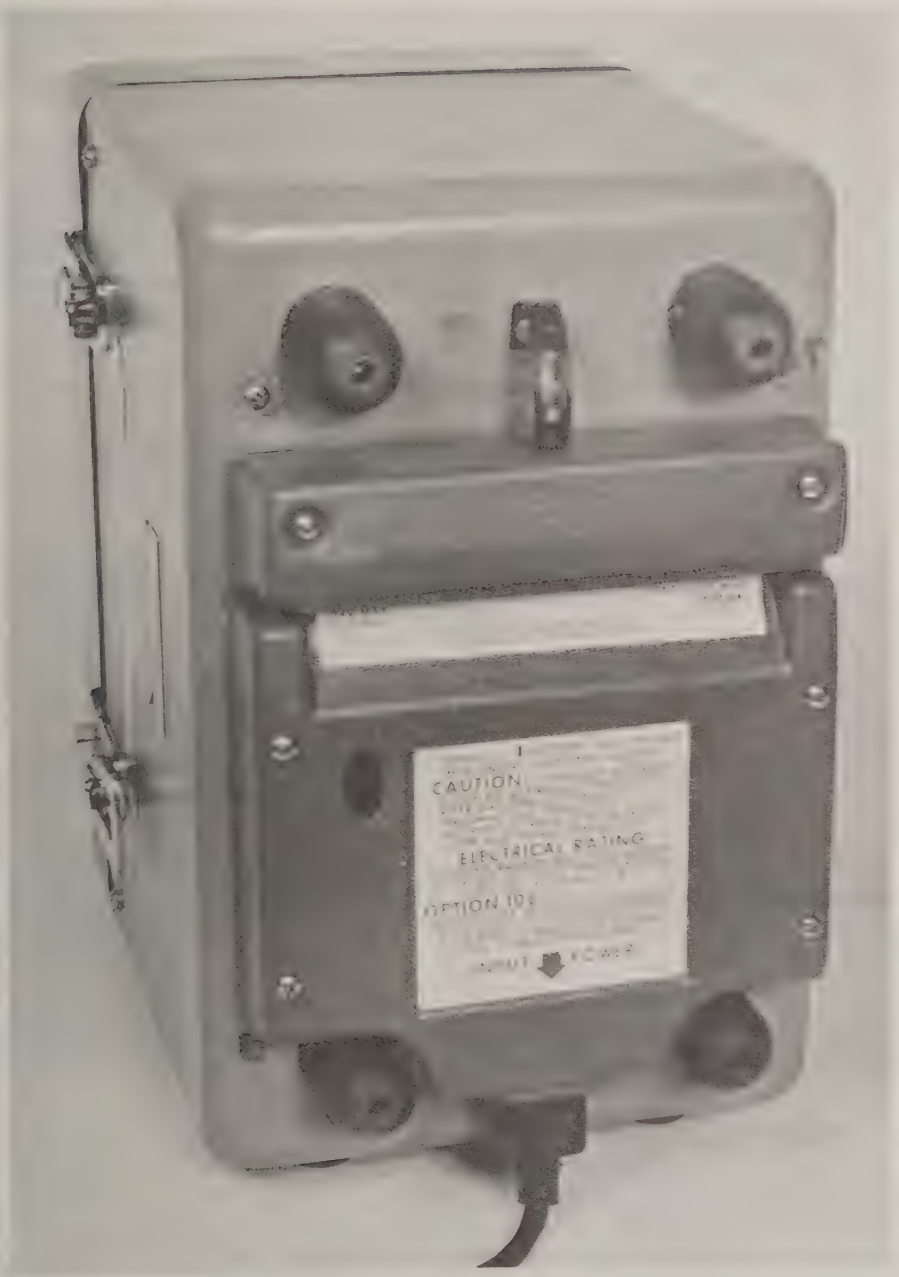


Figure 2-2. Rear View of Analyzer Showing Separate Power Source Connector

2.6.3 Unfasten the four screws and remove the plastic rear cover.

2.6.4 For operation from 90-140 volts, 47-65 Hz, or for 120-170 volts DC, place the line voltage selector switch on PC board A10 in the position labeled "115".

2.6.5 For operation from 180-280 volts, 47-65 Hz, place the line voltage selector switch on PC board A10 in the position labeled "230". Two high voltage taps on the input autotransformer are provided. For operation from 220-280 volts, 47-65 Hz, the red/white jumper wire on PC board A10 should be placed on the terminal labeled "240". For operation from 180-240 volts, 47-65 Hz, the red/white jumper wire should be placed on the terminal labeled "210".

2.6.6 Replace the rear cover. Securely fasten the four screws. (Do not replace terminal strip cover.)

2.7 CONNECTING ANALYZER TO AC AND DC VOLTAGE(S) TO BE MONITORED

2.7.1 Turn off the source of the voltage(s) to be monitored. Connect AC power (115V RMS for 616A or 230V RMS for 616B or 616C) to the channel A input terminal pair. Connect the DC voltages to be monitored to the channel B and C terminal pairs. Polarity is not important.

2.7.2 If the Analyzer is to activate an external alarm or control when a disturbance threshold is exceeded, connect the alarm or control to the two ALARM RELAY terminals.

2.7.3 If using Option 104, connect leads from circuit to be monitored to rear terminals marked OPT 104 observing polarity. Note that the time mark activating level is 5 to 12 volts DC.

2.7.4 When all connections have been completed, replace the top cover over the terminal strip and secure it to the case by tightening the two captive screws.

2.8 OPERATION

To prepare the Analyzer for operation, proceed as follows:

2.8.1 Set the SLOW AVG, SAG/SURGE, and IMPULSE screwdriver switches to the desired threshold values.

NOTE

If the disturbance characteristics of the line to be tested are unknown, start with low threshold values. If too many printouts are produced after the Analyzer is turned on, increase the threshold settings until the necessary data is provided in a convenient form.

2.8.2 Turn on the power and voltage source(s) to be monitored.

2.8.3 To operate the Analyzer in its normal print mode, depress the PRINT pushbutton to the "IN" position. If restricted printer operation is desired, depress the PRINT pushbutton to the "OUT" position.

2.8.4 To activate the 1-second audio alarm depress the ALARM pushbutton to the "IN" position.

2.8.5 Depress and hold the FEED pushbutton and check that paper advances evenly out of the printer. If necessary, guide end of tape out of printer opening.

NOTE

For information on installing a new paper tape roll, refer to paragraph 2.11.

2.8.6 Rotate the key switch from the OFF to the OPER position. Once the POWER ON message has been printed (approx. 10 sec delay), the Analyzer is functioning. The time should be set at this point.

2.9 CLOCK SETTING PROCEDURE

2.9.1 Rotate the key switch from the OPER to the SET position.

2.9.2 Advance the clock through 00:00:00 by depressing the FAST pushbutton, then advance the clock slightly past the real or system time to which the unit is to be synchronized. To do this, first depress the FAST or SLOW pushbutton (as appropriate) until the desired time printout is obtained. Now depress HOLD button to stop the instrument time until real or system time coincides with instrument time, then release HOLD button. It should be possible to synchronize instrument time to real or system time to within one second.

2.9.3 When the clock is properly set, depress RESET switch to clear out computer memories and to reset day counter to day 00.

2.9.4 Reset key switch to OPER position.

NOTE

Although the day counter cycles from day 00 to day 99, the count will return to 00 at the 100th day and normal operation will continue indefinitely.

2.9.5 No further procedures are required. Operation of the Analyzer is completely automatic. With the key switch in the OPER position, the key may be withdrawn to prevent inadvertent turnoff, clock alteration, or resetting of the Analyzer.

2.10 OPERATION WITH OPTION 101

When Option 101 is supplied with the Series 616 Analyzer, an additional screwdriver switch marked FREQ THRESHOLD is installed at the lower right hand corner of the Analyzer panel. This switch sets the frequency threshold above or below which a frequency printout is produced. For Option 101, only the 50/60 Hz (upper) markings on the switch are applicable. Simply set the switch to the desired threshold value (.5, 1, or 2 Hz). When the frequency of the monitored line voltage (channel A only) deviates by more than the selected threshold value, a printout similar to the following will be produced:

FREQ 060.5HZ
04:09:48

Since the frequency measurement is based upon counting cycles over a 1-second interval, a line voltage interruption of 5 cycles or more could cause a frequency disturbance to be selected and printed by the Analyzer. Therefore, in the case of a power interruption, the recorded frequency could fall as low as 42.7 Hz.

2.11 INSTALLATION OF PAPER TAPE (See figures 2-3 thru 2-5).

The Analyzer is shipped with a roll of paper already installed. During operation, when the paper supply becomes low, the unit will automatically print PAPER LOW (and operation will be shifted to the "PRINT OFF" mode) indicating that the paper roll should be replaced.

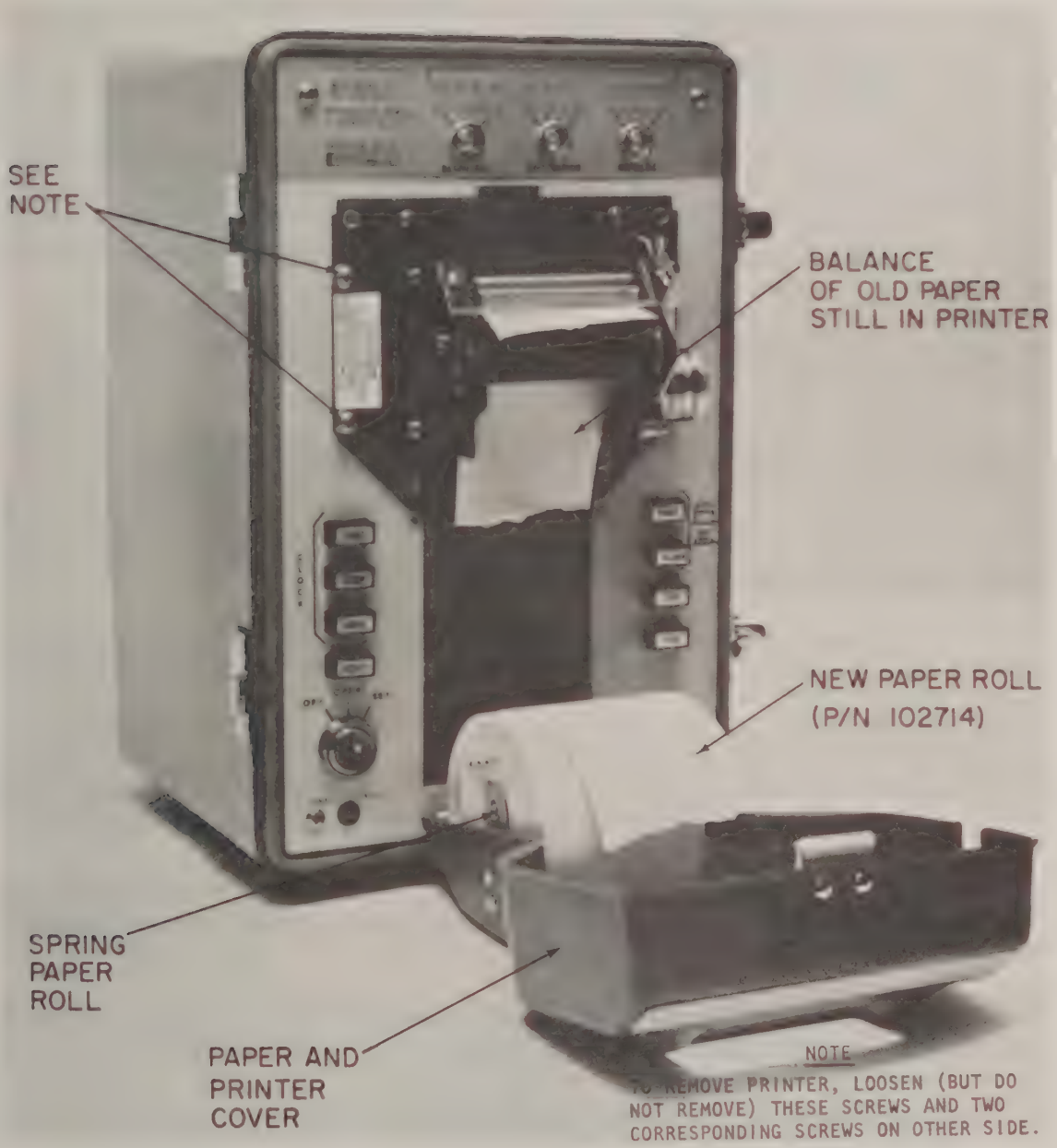

SEE NOTE
BALANCE OF OLD PAPER STILL IN PRINTER
NEW PAPER ROLL (P/N 102714)
SPRING PAPER ROLL
PAPER AND PRINTER COVER
NOTE
TO REMOVE PRINTER, LOOSEN (BUT DO NOT REMOVE) THESE SCREWS AND TWO CORRESPONDING SCREWS ON OTHER SIDE.

Figure 2-3. New Paper Roll Installed in Cover

NOTE

In the "printer off" mode, normal printout of disturbance data is inhibited and only the daily accumulated summary is produced. Therefore, if it is anticipated that a large number of disturbances will occur during a period of unattended operation, do not wait for a PAPER LOW condition - install a full roll of paper.

Before replacing the thermally sensitive paper, clean the printhead as described in paragraph 2.12. After cleaning the printhead, replace the paper roll as follows.

2.11.1 Depress upper edge of paper and printer cover and lower cover as shown in figure 2-3.

2.11.2 Tear paper roll just above old roll. Do not remove remaining paper from printer.

2.11.3 Push two spring paper holders outward to release old paper roll and remove roll.

2.11.4 Remove holding tab from new paper roll to release end of roll. Use a scissors to cut the edge of the paper straight.

2.11.5 Holding the paper roll so that it unrolls as shown in figure 2-3, expand the two spring paper holders, install the roll, then release the holders to lock the roll in place.

NOTE

If there is no paper in printer, proceed directly to step 2.11.9.

2.11.6 Ensuring that the new paper is aligned correctly to avoid jamming, insert the cut end between the rubber roller and the remaining old paper so that the old and new paper overlap. (See figure 2-4A.)

2.11.7 Depress and hold FEED pushbutton until the new paper comes into view and the old paper is completely out of the printer. (See figure 2-4B.)

2.11.8 Raise cover and guide paper through opening as shown in figure 2-1, then lock cover in place.

NOTE

Proceed with the following steps only if there is no paper in printer.

CAUTION

BE SURE THAT HANDS ARE CLEAN. ANY GREASE OR FOREIGN MATTER ON HANDS MAY CONTAMINATE ROLLER AND CAUSE PRINTER TO MALFUNCTION.

2.11.9 Using one hand, feed the cut end of the new paper between the rubber roller and the feed chute opening under the printer as shown in figure 2-5A. Using the thumb on the other hand, gently rotate rubber roller in the forward direction until the paper comes into view. (See figure 2-5B.)

2.11.10 Depress and hold FEED pushbutton to ascertain that paper moves smoothly. If not, repeat procedure of step 2.11.9.

2.11.11 Raise cover, guide paper tape through opening, then lock cover in place.

NOTE

Due to the coiling action of the paper on its spool, it is likely that repetitive printouts of the PAPER LOW message will occur until the paper supply is clearly below the triggering point of the optical paper sensors. This occurrence is intentional and should not be a cause for concern.

2.12 CLEANING PRINTHEAD

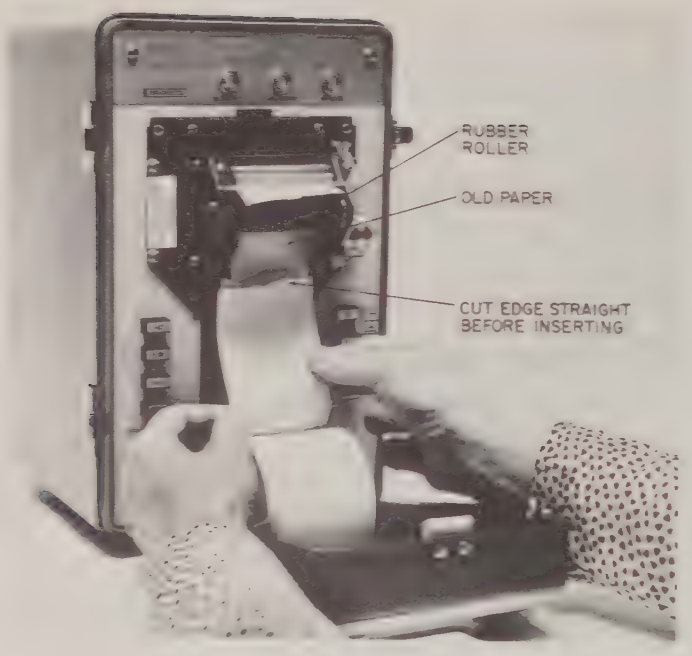
During the course of normal printer operation, minute particles of thermal sensitive material tend to be dislodged from the surface of the printer paper. These particles accumulate on the surface of the heating matrix in the printhead. This causes a reduction in heat-flow to the paper causing the following symptoms:

Print density too light
No printout
Missing dots

To clean the printhead in the simplest and preferred method, particles may be removed by inserting a length of bond paper (approximately 10 inches in length cut to width of 2.25 inches) into the printer and operating the printer by pressing the TEST button until the length of paper passes through the printer. Insert this paper in the same manner as if replacing the paper roll.

NOTE

For your convenience Dranetz has made available a precut paper strip (Dranetz P/N 103418). This paper serves as an abrasive which buffs the surface of the printhead clean. It is a recommended good practice to clean the printhead each time the thermal sensitive paper roll is replaced.



A

B

Figure 2-4. Inserting New Paper when some Paper is in Printer

A

B

Figure 2-5. Inserting New Paper when No Paper is in Printer

2.13 OPTION 105 INTERCONNECTIONS (FOR USE WITH 606-PA-600X)

Option 105 for Model 616 Analyzers utilizes Cable Assembly 110025-G1 (for Option 105 only) or Cable Assembly 110025-G3 (for both Options 105 and 106). See figure 2-6.

NOTE: Only Channel A of the Series 616 and the 606-PA-600X Adapter is used.

2.14 USE OF OPTION 106 (RS232C INTERFACE ADAPTER)

Option 106 allows the data from Model 616 Analyzers to be outputted to a remote printer or peripheral device via Interface Cable Assembly 110025-G( ).

NOTES

1. For Option 106 only, use Interface Cable Assembly 110025-G2. (See figure 2-7.)

2. For Option 106 with Option 105, use Interface Cable Assembly 110025-G3. (See figure 2-7.)

a. Option 106 Modes of Operation

1. Mode 1 - Local Printer On. This mode provides for normal Analyzer operation with remote duplication. If the CLEAR TO SEND "CTS" control line is true, data is transmitted. If the CTS line becomes false for more than 300 milliseconds, the RS232C output is disabled, allowing the local printer to resume. This allows for a limited end-of-line type of delay.

2. Mode 2 - Local Printer Off. At the time that the PRINT switch is put into the OFF position, a validity test is made of the CTS line. If CTS is false, then normal Analyzer operation is performed, where printout conforms to the reduced printout of daily and test summaries.

If CTS is true when the PRINT switch is put in the OFF position, then a swapping mode is initiated, where full fault data is transmitted to the remote. If CTS now becomes false, the local printer is swapped back on to prevent loss of data, and reverts back to remote if CTS becomes true.

This provides for automatic backup should the remote printer run out of paper. To disable this feature, connect the CTS line (pin 5) to RTS line (pin 4) at the connector.

3. Mode 3 - Remote Only Operation. This mode is intended for use where external control of output is required. Mode 3 is enabled by an internal jumper on the A3 board and with the PRINT switch in the OFF position.

Data is transmitted while CTS is true; while CTS is false, data transmission is held back indefinitely.

NOTE

The TIME printout will always be the time of transmission: the daily summary will not be reset until actual transmission of the daily summary is completed. Should the internal fault stack be filled, the short term summary will be enabled as with normal Analyzer operation.

To enable Mode 3, add jumper on position B of A3-J5. Option 106 is factory supplied for Modes 1 and 2. See figure 2-6 below.

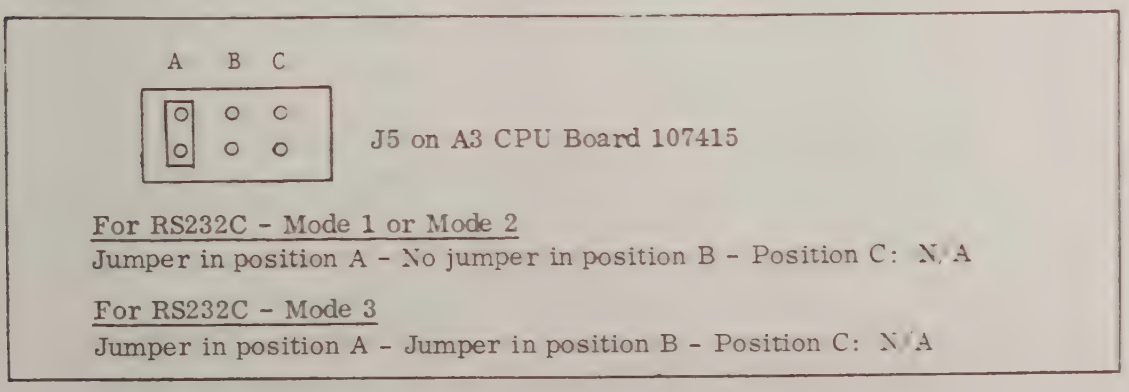

A B C
J5 on A3 CPU Board 107415
For RS232C - Mode 1 or Mode 2
Jumper in position A - No jumper in position B - Position C: N/A
For RS232C - Mode 3
Jumper in position A - Jumper in position B - Position C: N/A

Figure 2-6. Mode Selection via Jumper Block J5 on A3

b. Transmission Rates

A switch mounted in the Interface Cable Assembly (figure 2-9) provides for transmission or baud rate selection. Table 2-2 identifies the baud rate associated with each switch position.

NOTES

1. Because of timing internal to the Analyzer, actual data thruput is limited to 360 characters/second maximum.
2. A hole in the 50-pin male connector P1 of the Interface Cable Assembly provides access to the 16-position switch. Use the alignment tool supplied (JFD Adjustment Tool 5284) to select the desired baud rate. The arrow adjacent to the switch slot points to the switch position marked on the external decal. (Ignore internal switch markings.)

Table 2-2. Baud Rate Selection Chart

Position	Baud Rate
1*	50 Not Recommended
2*	75 Not Recommended
3	110
4	134.5
5	150
6	300
7	600
8	1200
9	1800
10	2000
11	2400
12	3600
13	4800
14	7200
15	9600
16*	19200 Not Recommended

*Positions 1, 2 and 16 are not compatible with Analyzer timing and should not be used.

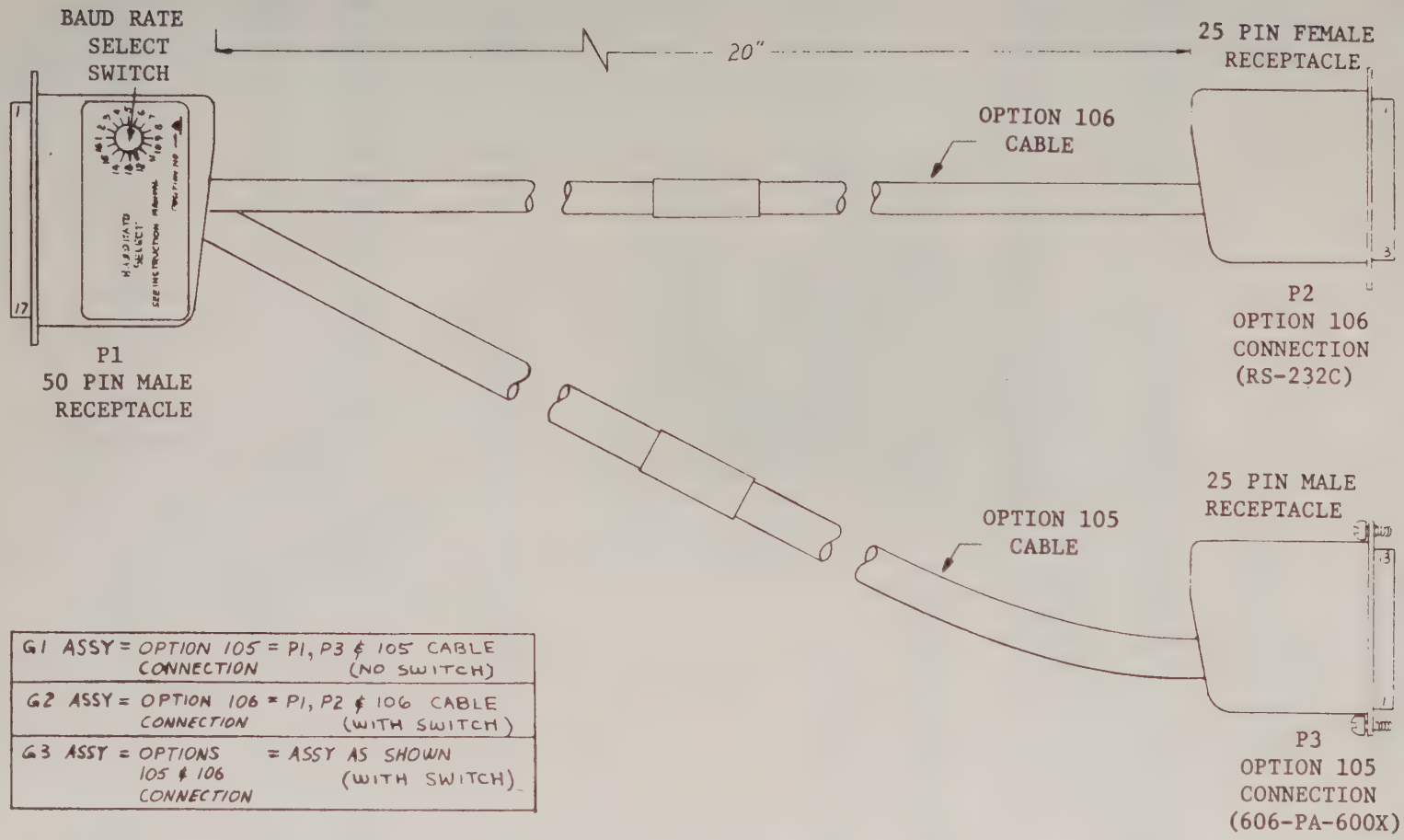


Figure 2-7. Interface Cable Assembly 110025-G( )

c. Data Format

Data is a duplicate of that printed on the local Analyzer printer and is sent in ASCII code format as follows:

1 Start Bit
7 Data Bits
1 Bit, Zero Parity
2 Stop Bits

Voltage and impedance levels conform to RS232C standard. The following control lines are used:

CA-RTS - Request to Send, always true
CB-CTS - Clear to Send, used to enable or disable transmissions as described in subpara. a above.

d. Interface Cable Pinouts
(Equivalent to TTY pinouts, for Modem connection.)

Pin	Function
1	Protective Ground (chassis)
2	Data to Remote
3	Data from Remote
4	Request to Send (output always true)
5	Clear to Send, Input for Control
6	Data Set Ready, Input for Control
7	Signal Ground
20	Not Used

For simplest connection, connect pin 4 to pins 5 and 6 and connect printer input to pin 2. Pin 7 is signal ground; pin 1 is frame ground.

2.15 REMOTE TEST SUMMARY

A test summary printout can be initiated from the remote by sending a Control T (DC4) character to the Analyzer. To enable this feature, pin 6 must be a logic true level. Connect pin 6 to pin 4 if not provided by the remote.

Control T is the only character recognized by the Analyzer. All others are ignored.

2.16 THRESHOLD SUMMARY PRINTOUT

A new feature added to the Model 616 causes the instrument to print out the settings of the threshold switches at the end of a test, reset or daily summary (not after a short term summary). A sample printout, made from a Model 616A, appears in figure 2-8.

```
FREQUENCY= 00.5 HZ
IMPULSE= 050/00.5V
SAG/SUR=  03/ 0.3V
SLO AVE=  03/ 0.3V
THRESHOLD SETTINGS

IMP 05.8V 0006 HTS
SAG 00 0V 0006 HTS
SUR 13.6V 0007 HTS
LO AVERAGE 09.0V
HI AVERAGE 12 4V
C 12.4VAV 00:03:01
IMP 06.0V 0008 HTS
SAG 00.0V 0006 HTS
SUR 13.6V 0006 HTS
LO AVERAGE 09.1V
HI AVERAGE 12.4V
B 12.3VAV 00:02:53
IMP 0604V 0008 HTS
SAG 000V 0007 HTS
SUR 136V 0004 HTS
LO AVERAGE 098V
HI AVERAGE 124V
A 124V AV 00 02:46
LO FREQ 053 0HZ
HI FREQ 060 2HZ
FREQ 060.0HZ
TEST DAY 00 ACCUM

C 12.3V AVG +
A 124V AVG
FREQ 060.0HZ +
B 12.3V AVG +
00 02:34

POWER ON 00:02:32



POWER OFF 00 02:16
```

Figure 2-8. Example of Threshold Summary Printout

SECTION III

PERFORMANCE TESTS

3.1 SCOPE

This section contains instructions for testing and verifying proper operation of the Analyzer. The procedure includes tests of basic performance characteristics. If any malfunction is detected when performing this procedure, whether specifically tested for or not, it should be corrected.

3.2 TEST EQUIPMENT REQUIRED

Table 3-1 lists the test equipment required for performance testing. Minimum equipment specifications are included in this table to assist in determining suitable items of substitution. It is recommended, however, that prior to substituting any test equipment, adequate equipment performance is verified.

TABLE 3-1. TEST EQUIPMENT REQUIRED

Item	Characteristics	Model
Line Disturbance Simulator	Input: 100-120 VAC, 50/60 Hz Output (% of Input) Avg* 90-110% Sag* 0-10% 20 Cycle max Surge* 11% Impulse* 0-200 Volts 5 usec typ. *Typical into 100K, 680 pf load	Dranetz Engineering Series 604
Model 604A-PA-1001 Simulator Adaptor	Channel A output: Same as Model 604A Channel B and C outputs: Avg: 9-11 VDC** Sag/Surge: 0-1 VDC** Impulse: 0-5V peak, 5 us typ.** **Into 10K load	

TABLE 3-1. TEST EQUIPMENT REQUIRED (cont)

Item	Characteristics	Model
Oscilloscope	Bandwidth DC: 0 Hz - 10 MHz AC: 2 Hz - 10 MHz Accuracy: 3% Rise time: 35 NS	Phillips PM 3234
Voltmeter	AC: 30 Hz - 1 MHz Accuracy - 1%	Ballantine 303-51
Ohmmeter		Simpson 260
Digital Voltmeter	0-100 VDC: 1% Accuracy	Fluke 8300A

3.3 SPECIFICATION TEST SUMMARY

Table 3-2 summarizes the methods used to test the Analyzer characteristics. Use this table in conjunction with the procedures presented in paragraphs 3.4 through 3.7 to test the Model 616A, 616B, or 616C.

As a further aid to evaluating the test procedure results, a typical printout is included at the end of this section. For further clarification, the printout is correlated to the specific paragraphs of the test procedure.

TABLE 3-2. SPECIFICATION TEST SUMMARY

Analyzer Characteristic	Specifications	Test Method
LINE-BATT power indicator	Green-External (LINE) source Red-Internal battery (BATT)	Visual, with key switch in OPER position.
Power On	Print Message XX:XX:XX RESET POWER ON XX:XX:XX	Verified by printout power applied (after 10 seconds).

TABLE 3-2. SPECIFICATION TEST SUMMARY (cont)

Analyzer Characteristic	Specifications	Test Method
Reset Mode with respect to OPER and SET positions	OPER position - no print SET position - "reset" printout; all accumulated data reinitialized	Press and release RESET switch with key switch in OPER and SET positions. Verified by printout.
Slow Average Measurements	Channel: Incr. Value A: 3, 5, 10, 15 B, C: 0.3, 0.5, 1.0, 1.5	Tested by applying input signal to a selected channel and changing that value by ± the selected threshold value. Verified by printout and repeated for each additional channel.
Sag/Surge Measurements	Channel: Incr. Value A: 3, 5, 10, 15 B, C: 0.3, 0.5, 1.0, 1.5	Tested by applying input signal to a selected channel and changing that value by ± the threshold value, for a limited number of cycles. Repeated for each additional channel.
Impulse Measurements	Channel: Incr. Value A: 50, 100, 200, 400 B, C: 0.5, 1.0, 2.0, 4.0	Tested by applying (to a selected channel) a half sine wave of approx. 5 usec width and amplitude in excess of increment value. Verified by printout and repeated independently for each additional channel.
Test Mode	Summary printout (worst case and number) of all previous disturbances. Typical printout format:	Depress and release the TEST switch. Verify printout by comparison to all previous disturbances.

TABLE 3-2. SPECIFICATION TEST SUMMARY (cont)

Analyzer Characteristic	Specifications	Test Method
Test Mode (cont)	IMP 200V 0012 HTS SAG 112V 0002 HTS SUR 128V 0003 HTS LO AVERAGE 114V HI AVERAGE 126V A 120V 09:23:45 TEST DAY 00 ACCUM	NOTE Test printout followed by a reset printout (without having pressed RESET switch) indicates internal memory is defective.
Reset Mode	Summary printout similar to test printout. All previous disturbances and day counter are cleared from all summary mode functions.	With key switch in SET position, depress and release RESET switch. Verify printout by comparison to all previous disturbances. Depress and release TEST switch and verify that all accumulated disturbances and day counter are re-initialized.
Short Term Accumulated Mode	Summary printout of disturbances that occur on the monitored signal (similar to test printout) which are not printed individually.	
	CASE I. PRINT switch is in the off position when disturbances occur and is then set to the on position.	Tested by setting the PRINT switch to the off position and generating several disturbances. Printout verifies disturbances when PRINT switch is set to the on position.
	CASE II. More than 15 disturbances occur prior to being printed.	Tested by generating disturbances at a rapid rate. Verified by printout.

TABLE 3-2. SPECIFICATION TEST SUMMARY (cont)

Analyzer Characteristic	Specifications	Test Method
	CASE III. Paper low mode. When the paper supply becomes low, a warning message is printed at various times. When the paper becomes too low, a reduction of printout occurs. When the Analyzer enters this mode, all disturbances are entered into a short term accumulated mode and are not individually printed. No other functions are affected.	Tested by opening the protective cover, generating disturbances, and then closing the cover. Verification is accomplished by comparison of printout and the disturbances entered.
Clock Hold	Prevents the time from being advanced. Printout of time continues as long as the CLOCK HOLD switch is depressed. Function is disabled when key switch is in OPER position.	Tested by pressing CLOCK HOLD switch (key switch in the SET position). Verified by printout. Also tested by depressing CLOCK HOLD switch with key switch in the OPER position. Verified by no printout and no effect on time.
Clock Slow	Advances time at approximately 1 min/sec rate. Printout of time continues as long as the CLOCK SLOW switch is depressed. Function is disabled when key switch is in OPER position.	Tested in similar manner as hold function. Verified by printout.

TABLE 3-2. SPECIFICATION TEST SUMMARY (cont)

Analyzer Characteristic	Specifications	Test Methods
Clock Fast	Advances time at approximately 1 hr/sec rate. Printout continues for the duration that the CLOCK FAST switch is depressed. Function is disabled when key switch is in OPER position.	Tested in similar manner as hold function. Verified by printout.
Daily Accumulated Mode	Summary of previous disturbances. Occurs at the end of each 24 hr period. Printout format is similar to reset. All accumulated disturbances are reinitialized and day counter is advanced.	Time clock is advanced with CLOCK SLOW and CLOCK FAST switches in excess of 23:59:59. Printout automatically follows. Verified by comparison with all previous disturbances. TEST switch is depressed and released to verify that day counter is advanced and accumulated disturbances are cleared.
Power Off Mode	A power off message and time are printed when the input power source is removed (or when the key switch is turned from the OPER to OFF position). Internal batteries maintain all accumulated data such that when power is restored no data is lost (except if unit is turned off).	Tested by entering data (disturbances) into the Analyzer and disconnecting the power source. Verified by printout and power indicator (red = battery operation). Restoration of power and the test function verify no data loss.

TABLE 3-2. SPECIFICATION TEST SUMMARY (cont)

Analyzer Characteristic	Specifications	Test Method
Audio Alarm	When a disturbance occurs, the alarm will be triggered for approximately 1 second. The alarm is enabled or disabled by front panel ALARM switch.	Tested by generating a disturbance and verifying operation.
External Alarm	Relay contacts are provided on the rear terminal strip. When a disturbance occurs the relay contacts close for approximately 1 second. (NOTE: Operation is independent of front panel ALARM switch.)	Tested by connecting an ohmmeter across the alarm terminals, generating a disturbance and verifying relay closure.

3.4 PRELIMINARY PROCEDURE

3.4.1 Verify that all power switches are in the off positions, then connect the Analyzer and the disturbance simulator to the appropriate power source. (Refer to Table 3-3.)

3.4.2 Set all THRESHOLD VOLTS switches to their maximum positions:

	616A		616B		616C	
	Ch. A	Ch. B & C	Ch. A	Ch. B & C	Ch. A	Ch. B & C
SLOW AVG	15	1.5	30	3.0	30	4.5
SAG/SURGE	15	1.5	30	3.0	30	4.5
IMPULSE	400	4.0	800	8.0	800	12.0

TABLE 3-3. SOURCE REQUIREMENTS

Input	616A	616B	616C
Power	90-140V AC, 50/60 Hz	90-140V, 50/60 Hz	90-140V, 50/60 Hz
Power with Option 102	180-280V AC, 50/60 Hz*	180-280V AC, 50/60 Hz*	180-280V AC, 50/60
Channel A	60-250V AC, 50/60 Hz	120-500V AC, 50/60 Hz	120-500V AC, 50/60
Channel B & C	±3.2V - ±25V DC	±6.2V - ±50V DC	±9.6V - ±75V DC

*180-240V AC/220-280V AC 50/60 Hz. Refer to "CONNECTING UNITS WITH OPTION 102 TO POWER SOURCE" (paragraph 2.6)

3.4.3 Set the PRINT switch to its On position.

3.4.4 Set the ALARM switch to its Off position.

3.4.5 Verify that an adequate paper supply exists and is installed properly (as per paragraph 2.11).

3.4.6 Connect the outputs of the adaptor to the input terminal of the analyzer as shown in figure 3-1.

3.4.7 Connect the AC voltmeter and oscilloscope to the channel A inputs of the Analyzer. Connect the digital voltmeter to the channel B input of the Analyzer.

CAUTION

IT IS ABSOLUTELY ESSENTIAL THAT THE DIGITAL DC VOLTMETER USED IN THIS PROCEDURE HAVE INPUTS THAT ARE ISOLATED. FAILURE TO OBSERVE THIS WARNING MAY RESULT IN DAMAGE TO THE ADAPTOR AND/OR SAFETY HAZARD.

3.4.8 Connect the ohmmeter to the relay connections provided on the rear terminal strip.

3.4.9 Verify that the ON/OFF switch on the 604A is set to OFF and the NORM/IMP CAL switch is set to NORM. Also set the channel selection switch to the channel A position.

3.4.10 Connect the adaptor to the output connector of the 604A.

3.4.11 Set the ON/OFF switch on the 604A to the ON position.

3.4.12 Verify that the AC voltmeter monitoring channel A reads approximately 120V AC ±15V.

3.4.13 Verify that the DC voltmeter reads approximately 11V DC ±2.0V for a 616A and/or 22V DC ±4V for a 616B and or 33V DC ±6V for a 616C.

3.5 TEST AND FUNCTIONAL OPERATION PROCEDURE

NOTE

Any action of the printer that is initiated by a specific step should be completed before proceeding.

3.5.1 Power Indicator and Power On Mode

A. Set the key switch to the OPER position and verify that LINE (green) indicator lights.

B. Wait 10 seconds and verify that a power on message is printed.

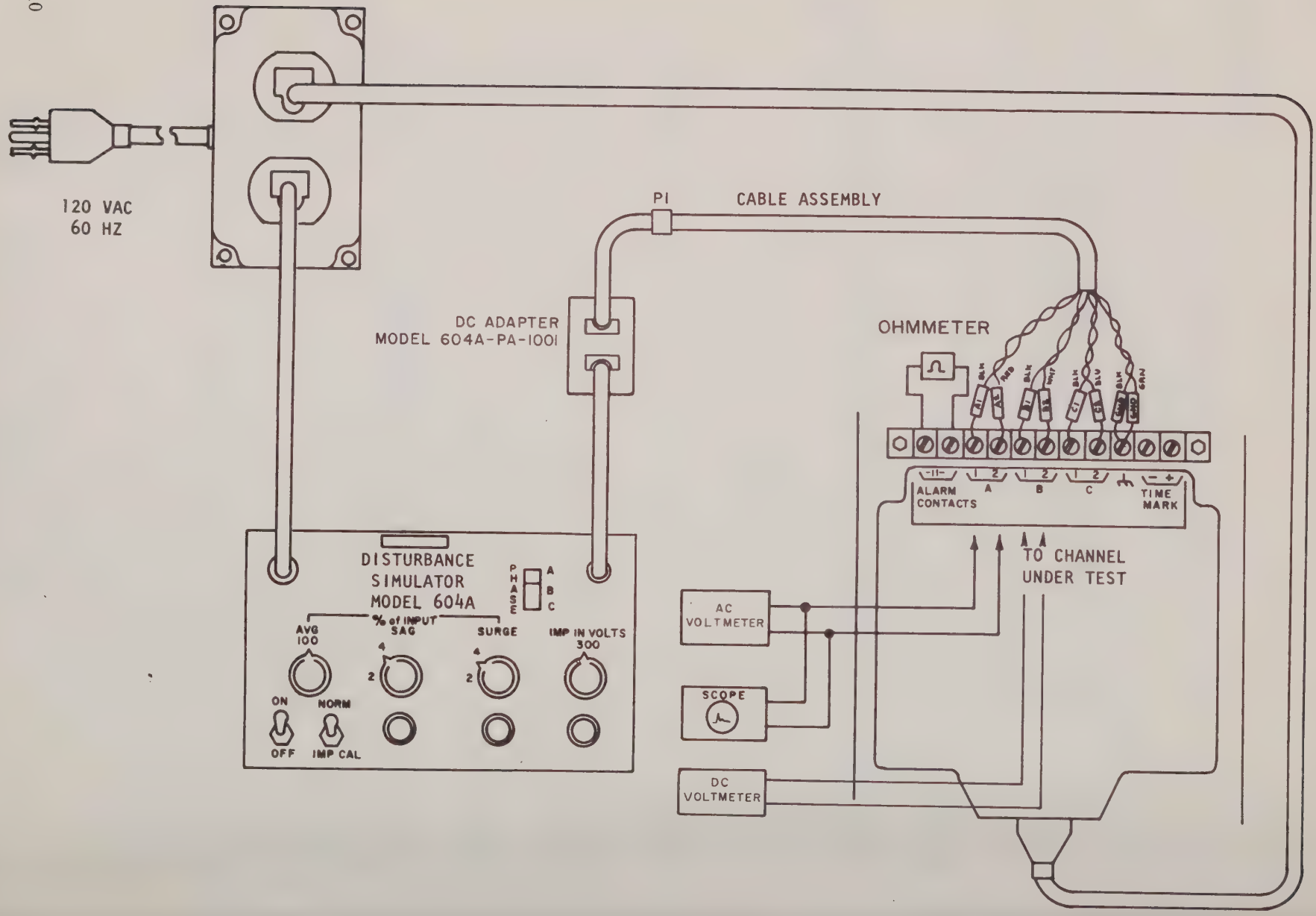


Figure 3-1 Typical Set-up Conditions - 610/604A Recorder

3.5.2 Slow Average Measurements

A. Set the key switch to the SET position.

B. Depress and release the RESET switch.

C. Verify average input measurement by comparing the value printed with the voltmeter reading.

D. Set the SLOW AVG threshold switch to the 3 (5, 10) volt position.

E. Adjust the input signal for a 3 (5, 10) volt difference from the present setting and verify that a corresponding printout occurred.

F. Repeat for values plus and minus over a range of inputs.

Slow Average Accuracy (616);
±1% of reading, ±1% of nominal input @ 60 Hz.

3.5.3 Sag/Surge Measurements

A. Set the SAG/SURGE threshold switch to the 3 (5, 10) volt position.

B. Set the desired percentage sag value (refer to Table 3-4), initiate the setting, and verify that a corresponding printout occurred. Repeat for each value shown.

Sag/Surge Accuracy (616);
±1% of Reading, ±1% of Nominal Input

TABLE 3-4. APPROXIMATE 604A SAG/SURGE SETTING FOR CHANNEL A

Sag/Surge Value	604A Input VAC 50/60 Hz				
	100V	110V	115V	120V	125V
3	3	3	3	3	3
5	5	5	5	5	4
10	10	9	9	9	8

C. Set the SAG/SURGE threshold switch to the 15 volt position.

3.5.4 Impulse Measurements, Channel A

A. Set the SLOW AVG threshold switch to the 10V (or the 15V) position.

B. Set the NORM/IMP CAL switch of the disturbance simulator to the IMP CAL position. (This step may be omitted. However, the IMP CAL position expedites the following procedures.) Ignore the series of printouts which will occur.

C. Set the IMPULSE threshold switch to the 50 volt position.

D. Set the desired impulse magnitude and initiate the setting on the disturbance simulator. Verify that the printout corresponds with the magnitude measured with the oscilloscope. Repeat for several different values.

Impulse Accuracy:
±5% of Reading ±1% of Maximum Value.

E. Set the IMPULSE threshold switch to the 400 volt position.

F. Set the NORM/IMP CAL switch of the line disturbance simulator to the NORM position.

G. Set the SLOW AVG and SAG/SURGE threshold switches to their 3 volt positions.

3.5.5 Test Mode

A. Depress and release the TEST switch.

B. Verify the printout by a comparison with the previous disturbances.

3.5.6 Clock Functions

A. Set key switch to OPER position, then depress and release CLOCK HOLD, SLOW and FAST switches. Verify that no printout has occurred.

B. Set the key switch to the SET position.

C. Depress the CLOCK HOLD switch for approximately 10 seconds. Verify that printout occurred while the switch was depressed and that the time did not advance.

D. Depress the CLOCK SLOW switch for approximately 10 seconds. Verify that a printout occurred while the switch was depressed, and that the time advanced approximately ten minutes.

E. Depress the CLOCK FAST switch for approximately 5 seconds. Verify that a printout occurred while the switch was depressed, and that the time advanced approximately five hours.

3.5.7 Daily Accumulated Mode

A. Advance the time (FAST, SLOW) such that it is advanced through 00:00:00. Verify that a daily accumulated count printout automatically followed.

B. Verify the printout by comparison to the test printout of 3.5.5A above.

C. Depress and release the TEST switch. Verify that the day counter is advanced and that all previous disturbances are cleared.

D. Set the key switch to the OPER position.

3.5.8 Short Term Accumulation Mode

A. Set the PRINT switch to the OFF position.

B. Initiate at least one line disturbance. Verify that no printout occurred.

C. Set the PRINT switch to the ON position. Verify that a short term accumulated printout occurs. Compare printout with disturbance generated in 3.5.8B.

D. Generate a series of disturbances (approx. 30) in rapid succession. Verify that printout format changed from individual disturbances to the short term accumulated format. Printout is verified by comparison of disturbances and the total of the individually printed and short term accumulated disturbances.

3.5.9 Paper Low Mode

A. Open the plastic cover on the front panel to expose the printer and paper supply. Verify that a paper low printout occurred.

B. Generate several disturbances. Verify that no printout occurred.

C. Close the plastic cover. Verify that a short term accumulated printout occurred.

3.5.10 Reset Function Mode

A. Depress and release the TEST switch. Verify that test printout occurs.

B. Set key switch to OPER position, then depress and release the RESET switch. Verify that no printout occurred.

C. Set the key switch to the SET position.

D. Depress and release the RESET switch. Verify printout by comparing it with test printout of 3.5.10A.

E. Depress and release the TEST switch. Verify that all accumulated disturbances have been cleared and that day counter has been reset to 00.

3.5.11 Audio Alarm

A. Set ALARM switch to the On position.

B. Generate a line disturbance. Verify alarm operation (1 second audio).

3.5.12 External Relay

Generate a line disturbance and verify relay closure with ohmmeter.

3.5.13 Power Off Mode

A. Depress and release the TEST switch.

B. Disconnect power from the Analyzer without setting the key switch to the OFF position.

C. Verify that a power-off printout occurred and that the red BATT indicator lights.

D. Reconnect power to the Analyzer.

E. Wait approximately 10 seconds.

F. Verify that power-on printout occurred and that the green LINE indicator lights. NOTE THAT NO RESET IS PRINTED.

G. Depress and release the TEST switch. Verify that printout compares with test printout of 3.5.13A. (NOTE: Depending on power source, additional impulse disturbances may occur.)

H. Set the key switch to the OFF position without removing power from the input terminals. Verify that a power-off printout occurred and that the power indicator goes out immediately following the printout.

3.6 CHANNEL B MONITORING

3.6.1 Set the channel selector switch on the 604A to the channel B position.

3.6.2 Repeat paragraphs 3.5.1 through 3.5.3. Note that channel B is the channel under test. The 604A/616A scale factor is approximately 10:1 for AVG and SAG/SURGE. The 604A/616B scale factor is approximately 10:2 for AVG and SAG/SURGE. The 604A/616C scale factor is approximately 10:3 for AVG and SAG/SURGE.

Do not connect an oscilloscope to the channel B or C input terminals while using the 604A DC Adaptor.

3.6.3 Set the SLOW AVG and SAG/SURGE THRESHOLD switches to their maximum positions (1.5V DC for 616A, 3.0V DC for 616B, 4.5V DC for 616C).

3.6.4 Set the NORM/IMP CAL switch on the 604A disturbance simulator to the IMP CAL position. Ignore the series of printouts which will occur.

3.6.5 Set the desired impulse magnitude and initiate the setting on the 604A disturbance simulator. The scale factor for the 604A/616A, B, C is approximately 100:1. Verify that the printout corresponds with the setting on the 604A.

3.6.6 Repeat paragraph 3.6.5 for various amplitude impulse settings.

3.7 CHANNEL C MONITORING

3.7.1 Set the key switch to the OFF position.

3.7.2 Set the ON/OFF switch on the 604A to the OFF position.

3.7.3 Reconnect the DC voltmeter to the channel C input.

NOTE

Do not connect an oscilloscope to the channel B or C input terminals while using the 604A DC Adaptor.

3.7.4 Set the ON/OFF switch on the 604A to the ON position. (NORM/IMP CAL switch set to NORM position.)

3.7.5 Repeat paragraphs 3.5.1 through 3.5.3.

3.7.6 Set the SLOW AVG and SAG/SURGE THRESHOLD switches to their maximum positions.

3.7.7 Set the NORM/IMP CAL switch on the 604A to the IMP CAL position. Ignore the series of printouts which will occur.

3.7.8 Set the desired impulse magnitude and initiate the setting on the 604A disturbance simulator. The scale factor for the 604A/616A, B, C is approximately 100:1. Verify that the printout corresponds with the setting on the 604A.

3.7.9 Repeat paragraph 3.6.5 for various amplitude impulse settings.

TYPICAL PRINT-OUT RESULTS OF PHASE A MONITORING

A 122V AVG -
08:10:57

A 125V AVG -
08:10:54

A 128V AVG -
08:10:51

A 131V AVG -
08:10:47

A 134V AVG +
08:10:41

A 131V AVG +
08:10:39

A 128V AVG +
08:10:36

A 125V AVG +
08:10:32

A 122V AVG +
08:10:26 3.5.2E

C 12.0V AVG +
A 11.9V AVG +
B 120V AVG +
08:09:46

RESET

HI AVERAGE 12.0V
C 11.9V AV 08:09:43
HI AVERAGE 12.0V
B 12.0V AV 08:09:41
HI AVERAGE 120V
A 119V AV 08:09:38
RESET DAY 00 ACCUM 3.5.2B

C 11.9V AVG +
A 11.9V AVG +
B 120V AVG +
08:09:23

RESET

POWER ON 08:09:22 3.5.1B

A 109V AVG +
08:13:17

A 104V AVG -
08:13:10

A 109V AVG -
08:13:02

A 114V AVG -
08:12:54

A 119V AVG -
08:12:47

A 124V AVG -
08:12:42

A 123V AVG -
08:12:39

A 134V AVG -
08:12:34

A 139V AVG +
08:12:24

A 134V AVG +
08:12:19

A 123V AVG +
08:12:11

A 124V AVG +
08:12:05

A 119V AVG +
08:11:50

A 116V AVG +
08:11:46

A 113V AVG +
08:11:41

A 110V AVG +
08:11:37

A 107V AVG -
08:11:31

A 0116V IMPULSE
02:18:12

3.5.4D A 0072V IMPULSE
08:18:05

A 035V AVG -
A 052V AVG -
A 068V AVG -
A 086V AVG -
A 104V AVG -
3.5.4B 08:17:36

0012 CYCLES
A 130V SURGE
08:16:03

0012 CYCLES
A 109V SAG
08:15:59

0015 CYCLES
A 125V SURGE
08:15:37

0014 CYCLES
A 113V SAG
08:15:33

0003 CYCLES
A 122V SURGE
08:15:10

0004 CYCLES
A 117V SAG
0010 CYCLES
A 117V SAG
3.5.3B 08:15:03

A 119V AVG +
08:14:35

A 109V AVG -
08:14:09

A 119V AVG -
08:13:56

A 129V AVG +
08:13:42

```
#08:24:37
#08:24:00
#08:23:25                3.5.6D
#08:23:16
#08:23:15
#08:23:15
#08:23:15
#08:23:15
#08:23:15
#08:23:15
#08:23:15
#08:23:15
#08:23:15
#08:23:15
#08:23:15
#08:23:15 <------------- 3.5.6C
SUR 18.1V 0002 HTS
LO AVERAGE 11.9V
HI AVERAGE 12.0V
C 12.0V AV 08:22:29
SAG 10.7V 0001 HTS
SUR 18.2V 0002 HTS
LO AVERAGE 10.9V
HI AVERAGE 13.1V
B 12.0V AV 08:22:23
IMP 0216V 0005 HTS
SAG 000V 0005 HTS
SUR 130V 0004 HTS
LO AVERAGE 032V
HI AVERAGE 141V
A 120V AV 08:22:18   3.5.5A
TEST DAY 00 ACCUM <----------

A 120V AVG +
08:21:10

0206 CYCLES
A 120V SURGE
A 111V AVG +
A 096V AVG +
A 081V AV +
A 065V AVG +
A 050V AVG +
<------------ 3.5.4E
```

```
                                    3.5.9A
HI AVERAGE 121V                  ----------> PAPER LOW 00:05:43
A 120V AV 00:03:47
TEST DAY 01 ACCUM        3.5.7C

                         <----------
SUR 181V 0002 HTS
LO AVERAGE 11.9V
HI AVERAGE 12.1V
C 120V AV 00:03:32
SAG 10.7V 0001 HTS
SUR 18.2V 0002 HTS
LO AVERAGE 11.9V
HI AVERAGE 12.1V
B 12.1V AV 00:03:26
IMP 0216V 0005 HTS
SAG 000V 0005 HTS
SUR 130V 0004 HTS
LO AVERAGE 032V
HI AVERAGE 141V
A 120V AV 00:03:20
DAY 00 ACCUM             3.5.7B

                         <----------
#00:03:17
#23:29:17
#22:55:17
#22:19:17
#21:45:17
#21:09:17
#20:33:17
#19:56:17
#19:20:17
#18:46:17
#18:10:17
#17:34:17
#16:58:17
#16:23:17
#15:46:17
#15:11:17
#14:35:17
#14:35:17
#13:59:17
#13:23:17                3.5.7A
#12:42:17

                         <----------
#12:41:51
#12:05:51
#11:30:51
#10:55:51                3.5.8D
#10:20:51
#09:43:51
#09:08:51                3.5.6E
#08:31:51
                         <----------
#08:31:41
#08:31:09
#08:30:34                3.5.8C
#08:29:58
                         3.5.8A
                         ----------> PRINT OFF 00:04:58
```

```
C 12.2V AV 00:05:43
B 12.2V AV 00:05:42
SAG 109V 0005 HTS
SUR 130V 0005 HTS
A 120V AV 00:05:38
SHORT TERM ACCUM

0012 CYCLES
A 131V SURGE
0013 CYCLES
A 109V SAG
0011 CYCLES
A 131V SURGE
0011 CYCLES
A 109V SAG
0011 CYCLES
A 131V SURGE
0011 CYCLES
A 109V SAG
0010 CYCLES
A 130V SURGE
0009 CYCLES
A 109V SAG
0010 CYCLES
A 131V SURGE
0008 CYCLES
A 109V SAG
0010 CYCLES
A 130V SURGE
0002 CYCLES
A 109V SAG
0012 CYCLES
A 130V SURGE
0010 CYCLES
A 109V SAG
0012 CYCLES
A 130V SURGE
0011 CYCLES
A 109V SAG
0014 CYCLES
A 131V SURGE
0010 CYCLES
A 109V SAG
0013 CYCLES
A 130V SURGE
0010 CYCLES
A 109V SAG
00:05:05

C 12.2V AV 00:04:58
B 12.2V AV 00:04:57
SAG 109V 0001 HTS
A 120V AV 00:04:55
SHORT TERM ACCUM
PRINT OFF 00:04:58
```

0006 CYCLES
A 130V SURGE
00:07:37 ← 3.5.12

0007 CYCLES
A 109V SAG
00:07:28 ← 3.5.11B

LO AVERAGE 12.1V
HI AVERAGE 12.2V
C 12.2V AV 00:07:20
HI AVERAGE 12.2V
B 12.2V AV 00:07:18
HI AVERAGE 120V
A 120V AV 00:07:16 ← 3.5.10E
TEST DAY 00 ACCUM

C 12.2V AVG +
A 12.0V AVG +
B 12.2V AVG +
00:07:05

RESET

HI AVERAGE 12.2V
C 12.2V AV 00:07:02
LO AVERAGE 12.1V
HI AVERAGE 12.2V
B 12.2V AV 00:06:59
SAG 109V 0018 HTS
SUR 131V 0017 HTS
LO AVERAGE 119V
HI AVERAGE 121V
A 120V AV 00:06:54 ← 3.5.10D
RESET DAY 01 ACCUM

HI AVERAGE 12.2V
C 12.2V AV 00:06:31
LO AVERAGE 12.1V
HI AVERAGE 12.2V
B 12.2V AV 00:06:27
SAG 109V 0018 HTS
SUR 131V 0017 HTS
LO AVERAGE 119V
HI AVERAGE 121V
A 120V 00:06:22 ← 3.5.10A
TEST DAY 01 ACCUM

C 12.1V AV 00:06:05
B 12.2V AV 00:06:04
SAG 109V 0002 HTS
SUR 130V 0002 HTS ← 3.5.9C
A 120V AV 00:06:00

3.5.13H
POWER OFF 00:09:09

LO AVERAGE 12.1V
HI AVERAGE 12.2V
C 12.2V AV 00:08:57
LO AVERAGE 12.1V
HI AVERAGE 12.2V
B 12.2V AV 00:08:53
SAG 109V 0001 HTS
SUR 130V 0001 HTS
LO AVERAGE 119V
HI AVERAGE 121V
A 120V AV 00:08:48 ← 3.5.13G
TEST DAY 00 ACCUM

3.5.13F
POWER ON 00:08:27

3.5.13B
POWER OFF 00:08:07

LO AVERAGE 12.1V
HI AVERAGE 12.2V
C 12.2V AV 00:07:57
HI AVERAGE 12.2V
B 12.2V AV 00:07:55
SAG 109V 0001 HTS
SUR 130V 0001 HTS
LO AVERAGE 119V
HI AVERAGE 121V
A 120V AV 00:07:50 ← 3.5.13A
TEST DAY 00 ACCUM

APPENDIX A

TYPICAL DISTURBANCES AND MODEL 616 RESPONSES

A-1. INTRODUCTION

This section presents a number of disturbances that might be applied to a Model 616 Line Disturbance Analyzer, ranging from a single half-cycle dropout to a multiple sag/surge disturbance. Typical printouts for each type of disturbance are shown and each is described. Note that some of these disturbances are greatly exaggerated for clarity.

A-2. SINGLE HALF-CYCLE DROPOUT

Figure A-1A shows the input waveform of a 115V RMS line having a single half-cycle dropout. Since the Model 616 measures sags and surges over a full cycle, the sag/surge cycle detector will measure a single 57V RMS cycle and provide the printout shown. If the dropout were partial, the voltage reading would fall between 57V and 115V.

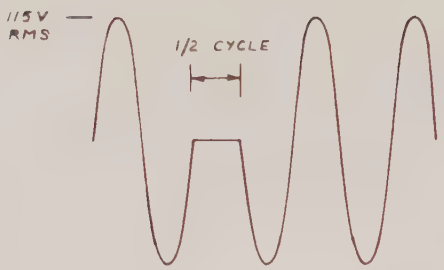
A-3. FULL-CYCLE DROPOUTS FROM 1 TO 15 CYCLES

If the input drops out for a number of cycles up to (approximately) 15, the sag/surge detector will measure zero volts over at least one complete cycle, and the cycle counter will count the number of cycles for which the voltage was at least one threshold value from the average voltage. The printout will be as shown in figure A-1B and will indicate the number of cycles for which low voltage was measured.

A-4. DROPOUTS OF 16 OR MORE CYCLES

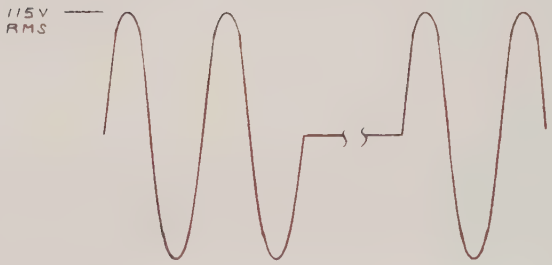
Figure A-1C shows the input voltage envelope, and the resultant printout for a 16 cycle dropout. In this case the averaging detector output has changed by the 3 volt threshold, so that:

1) A 112V AVG printout occurs.
2) A surge to 115 volts is measured (with respect to the 112V AVG) when the voltage recovers from the dropout.



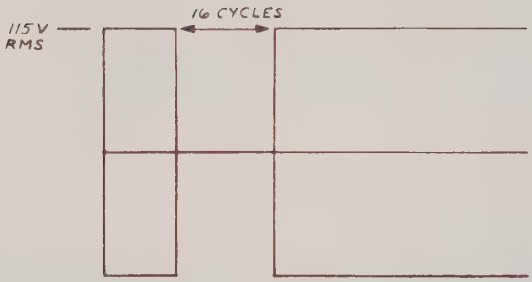
0001 CYCLE
57V SAG
00:12:01

A. 1/2 Cycle Dropout



0001 CYCLES
000V SAG
00:12:01
} UP TO 15 CYCLES

B. 1 Cycle to 15 Cycle Dropouts



0003 CYCLES
115V SURGE
115V AVG+
16 CYCLES
000V SAG
112V AVG
00:12:01

C. 16 Cycle Dropout

Figure A-1. Effect of Cycle Dropouts

A-5. REPETITIVE DROPOUTS

If the time between repetitive dropouts is long enough for the averaging detector output to recover fully, the results for each dropout will be the same as given above, until the internal memory fills up and the "short term accumulate" mode is entered. If the time between dropouts is short, a combination of SAG, SURGE, AVG, and short term ACCUM printouts will occur.

A-6. LONG SAGS

The sag/surge detector output is continually compared by the Model 616 processor to the long-term average output of the averaging detector. This averaging detector has a time constant of approximately 3 seconds, and results in a settling time of approximately 10 seconds.

If a long sag occurs, such as is shown in figure A-2, the cycle detector immediately detects the new voltage (176 volts in Figure A-2A). The averaging detector output starts to change immediately, and approaches the new voltage slowly. As soon as the difference between the averaging detector output and the cycle detector output exceeds the sag/surge threshold (3 volts in figure A-2(B), the cycle counter is started. From figure A-2B, it is evident that this will occur at the start of the disturbance at t=0. As long as the difference remains greater than the threshold, cycles will be counted.

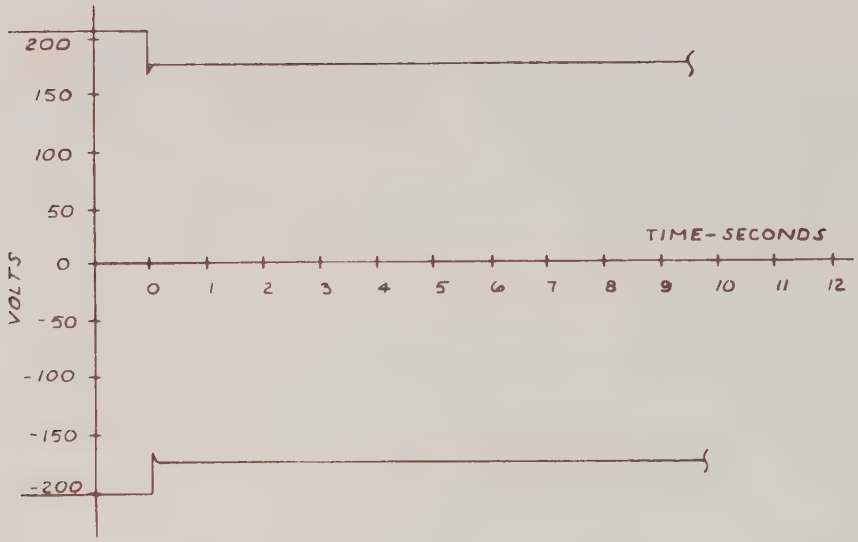
---

* Time Constant

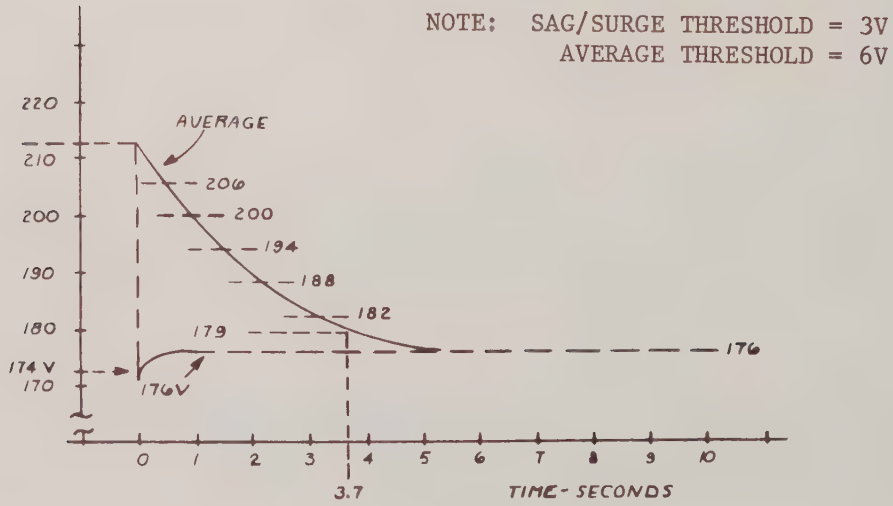
The "time constant" of the response of a network is defined, in terms of a simple exponential characteristic, as the time required for the output response to a step function input to change by $(1 - 1/\epsilon)$; approximately 63%. This definition is usually extended to include all monitonic response functions.

Settling Time

The "settling time" of a network, system or instrument is defined as the time required for the output response, or indication, to differ from the final value by less than the rated maximum error. When no rated maximum is specified, 1% is usually used to define "settling time."



A. Input Disturbance-Long Sag



B. Average Detector Output-Long Sag

Figure A-2. Typical Disturbance-Long Sag

While the cycles are being counted, the output of the averaging detector changes from the initial voltage (212V in figure A-2B) to the final voltage (176V in figure A-2B) following a response curve which has a time constant of approximately 3 seconds. Each time the averaging detector output changes by the threshold value (6 volts in figure A-2B), a new "average" value is printed. Thus new averages will be printed, for the disturbance of figure A-2, at 206V, 200V, 194V, 188V, 182V, and finally, at 176V.

When the output of the averaging detector reaches 179 volts, at about 3.7 seconds, the sag/surge detector concludes that the sag is over. This response occurs because a sag is defined as the condition in which the difference between the outputs of the cycle detector and the averaging detector exceeds the threshold value (3 volts, in this case). For this reason, the cycle count will stop at 3.7 seconds and a SAG printout will occur.

Figure A-3 shows the disturbance of figure A-2 in more detail and the printout which results. During the time that the cycle counter is active (i.e., while the difference in sag/surge and slow average is greater than 6 volts RMS), there will be no sag/surge printout. However, as indicated above, as the output of the averaging detector changes by the threshold value, average printouts will occur (after temporary storage in the memory). When the cycle count stops (at 3.7 seconds, in this case), the lowest sag voltage (174 volts) and cycle count (222 cycles) will be printed. After this, any further average changes (only 176V in this case) will be printed.

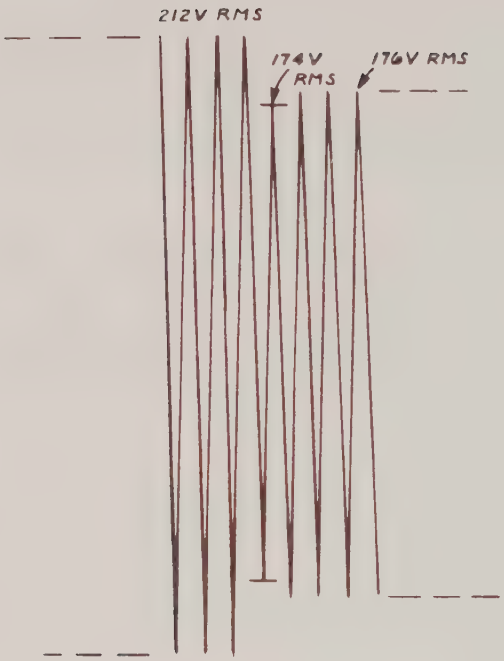
This interaction between the averaging detector and the sag/surge detector will occur any time a sudden change in voltage occurs of sufficient magnitude and duration to affect the averaging detector. This will be shown in the following examples.

A-7. SHORT SAG, LONG SURGE, LONG SAG

Figure A-4 shows a disturbance consisting of a short sag from 176V to 136V for 6 cycles, a surge to 212V for 12 seconds, and a long sag back to 176 volts. The resulting printout is shown below, and it follows the disturbance in the following manner.

The initial sag, lasting 6 cycles, is detected at 11:00:08. During this time the averaging detector output changes by less than the threshold setting (6 volts) so that only the sag is detected and recorded.

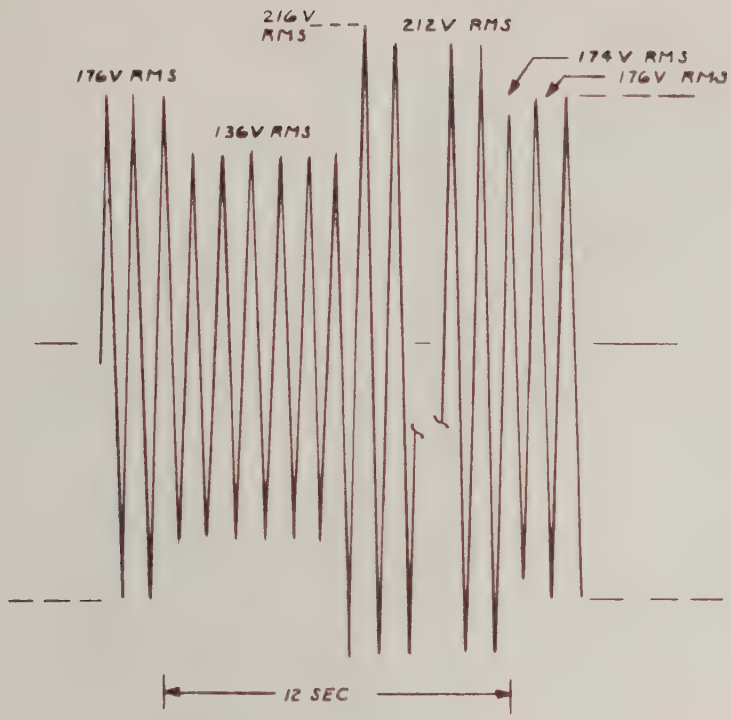
The surge to 212 volts is detected by the cycle detector, and the cycle count is started. During the 12 seconds, the output of the averaging detector increases (analagous to the average change in par. A-6) and average printouts occur each time the output changes by 6 volts. When the difference between



A 176V AVG- ← FINAL AVERAGE
0222 CYCLES
A 174V SAG — INITIAL SAG
A 182V AVG-
A 188V AVG-
A 194V AVG-
A 300V AVG- — AVERAGE DECREASES FROM 212V TO 182V
A 306V AVG-
11:00:31

↑ READ UP

Figure A-3. Model 616 Response to Long Sag



A 176V AVG-
0222 CYCLES
A 174V SAG

SAG TO 174V AT 12 SEC

A 182V AVG-
A 188V AVG-
A 194V AVG-
A 200V AVG-
A 206V AVG-
11:00:31

AVERAGE DECREASES FROM 212V TO 176V

0208 CYCLES
A 216V SURGE

INITIAL SURGE TO 216V CYCLES COUNTED FOR 3-1/3 SEC

A 212V AVG+
A 206V AVG+
A 200V AVG+
A 194V AVG+
A 188V AVG+
A 182V AVG+

12 SEC AT 212V. AVERAGE INCREASES FROM 176V TO 212V

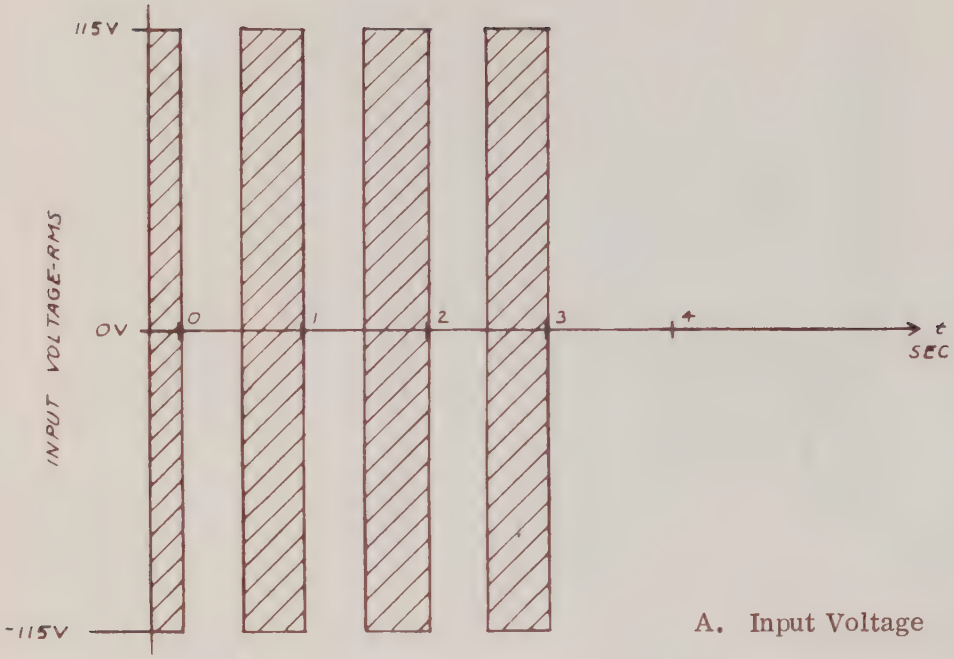
0006 CYCLES
A 136V SAG

6 CYCLES AT 136V

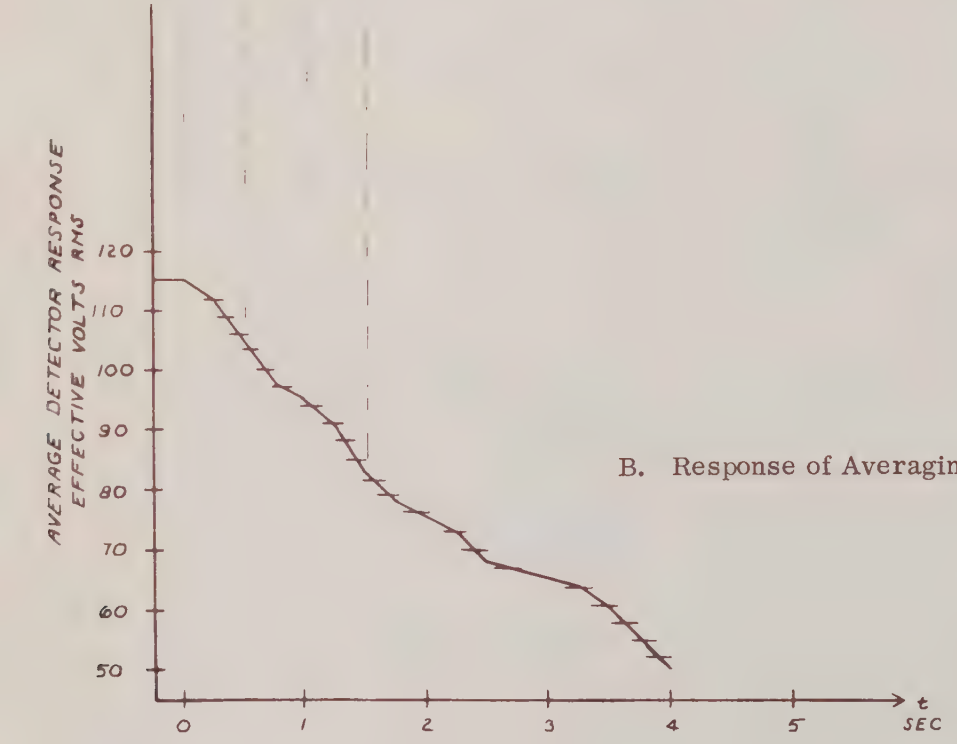
11:00:08

READ UP

Figure A-4. Complex Disturbance



A. Input Voltage



B. Response of Averaging Detector

Figure A-5. Effects of Repeated Dropouts (Sheet 1 of 2)

```
C 001V AV 00:13:48
B 115V AV 00:13:47
SAG 000V 0001 HTS
SUR 115V 0001 HTS
LO AVERAGE 032V
A 000V AV 00:13:42
FREQ 060.0HZ
SHORT TERM ACCUM ◄——MEMORY FULL

A 075V AVG-
A 079V AVG-                  ————————————
0029 CYCLES
A 115V SURGE                    SECOND
A 082V AVG-                     RECOVERY
A 085V AVG-                  ————————————
0029 CYCLES
A 000V SAG                      SECOND
A 088V AVG-                     DROPOUT
A 091V AVG-
A 094V AVG-
A 097V AVG-                  ————————————
0027 CYCLES
A 116V SURGE                    FIRST
A 100V AVG-                     RECOVERY
A 103V AVG-                  ————————————
0033 CYCLES
                                FIRST
A 000V SAG                      DROPOUT
A 106V AVG-
A 109V AVG-
A 112V AVG-                  ————————————
00:13:22
```

C. Typical Printout for Alternating Sags and Surges (Average Threshold at 3V)

Figure A-5. Effects of Repeated Dropouts (Sheet 2 of 2)

the sag/surge detector and averaging detector output falls to less than 3 volts (the sag/surge threshold) the cycle counter stops and the surge to 216 volts for 208 cycles is recorded.

At the end of 12 seconds, a sag from 212V to 176V is experienced. This is detected and recorded exactly as in par. A-6 above.

A-8. ALTERNATING SAGS AND SURGES DUE TO REPEATED DROP-OUTS

A common occurrence during power system faults is a series of voltage dropouts and recoveries as the system attempts to recover from the fault. Figure A-5A shows the envelope of such a fault condition, consisting of drop-outs and recoveries at a 0.5 second rate. The averaging detector starts to respond to the changing input immediately, and the resulting averaging detector output is shown in figure A-5B. If the averaging detector threshold were set at 3 volts, printouts would be initiated at the points marked with a short horizontal bar. In addition, sag and surge cycle counts would occur as indicated in figure A-5A.

Figure A-5C is the printout which results from the input shown in figure A-5A. During the first "off" period, sag cycle counts are started and the average printouts occur each time the averaging detector output changes by the threshold (3 volts). When the input is turned "on" again, the sag cycle count is stopped and the surge cycle count is started. At this time the sag printout (000V) and the cycle count (0033 CYCLES) occur. An impulse may sometimes be recorded for this type of waveform because there may be a sudden change in instantaneous voltage which exceeds the impulse threshold.

The output of the averaging detector continues to drop but at a slower rate, so that fewer average printouts occur during the surge. When the input again goes "off," the surge cycle count stops and another sag count starts. The surge count is then printed out.

With this type of input disturbance, and with the threshold set at 6V or 3V, it is possible that the combination of average readings, sag/surge readings and (occasional) impulse readings may overload the internal real-time memory, which is capable of storing up to 16 different disturbances. If this occurs, the Model 616 will go into the "short-term accumulate" mode and will print out, as soon as the disturbances stop, the accumulated data for each type of disturbance.

APPENDIX B. INSTALLING PAPER TAPE IN ANALYZERS USING THERMAL PRINTER P/N 102889

B-1. INTRODUCTION

An earlier version of the Model 616 Analyzer is equipped with a different Thermal Printer than the later one shown in the body of this manual. The earlier printer may be easily identified by the presence of a paper advance knob. (See figure B-1.) When installing paper tape in such printers, refer to the instructions in the following pages.

Figure B-1. Series 616 Analyzer Equipped with Thermal Printer Part No. 102889

B-2. INSTALLATION OF PAPER TAPE (See figure B-2.)

The Analyzer is shipped with a roll of paper already installed. During operation, when the paper supply becomes low, the unit will automatically print PAPER LOW (and operation will be shifted to the "PRINT OFF" mode) indicating that the paper roll should be replaced.

NOTE

In the "printer off" mode, normal printout of disturbance data is inhibited and only the daily accumulated summary is produced. Therefore, if it is anticipated that a large number of disturbances will occur during a period of unattended operation, do not wait for a PAPER LOW condition — install a full roll of paper.

Before replacing the thermally sensitive paper, clean the printhead as described in paragraph 2.12. After cleaning the printhead, replace the paper roll as follows:

a. Depress upper edge of paper and printer cover and lower cover as shown in figure B-2.

b. Tear paper roll just above old roll.

c. Rotate paper advance knob counterclockwise to advance remaining paper from printer.

d. Push two spring paper holders outward to release old paper roll and remove roll.

e. Remove holding tab from new paper roll to release end of roll. Use a scissors to cut the edge of the paper straight.

f. Holding the paper roll so that it unrolls as shown in figure B-2, expand the two spring paper holders, install the roll, then release the holders to lock the roll in place.

g. Feed the cut end of the roll into the opening under the printer, as shown, then slowly rotate the paper advance knob counterclockwise until the paper end comes into view.

CAUTION

To avoid damaging the printer, observe the following precautions:

1. Never turn the paper advance knob clockwise.
2. Never move or lift the printhead.

h. Lift the serrated plastic guide.

i. Rotate the paper advance knob counterclockwise until about 6 inches of paper extends from the printer.

j. Raise cover, guide paper tape through opening, then lock cover in place.

NOTE

Due to the coiling action of the paper on its spool, it is likely that repetitive printouts of the PAPER LOW message will occur until the paper supply is clearly below the triggering point of the optical paper sensors. This occurrence is intentional and should not be a cause for concern.

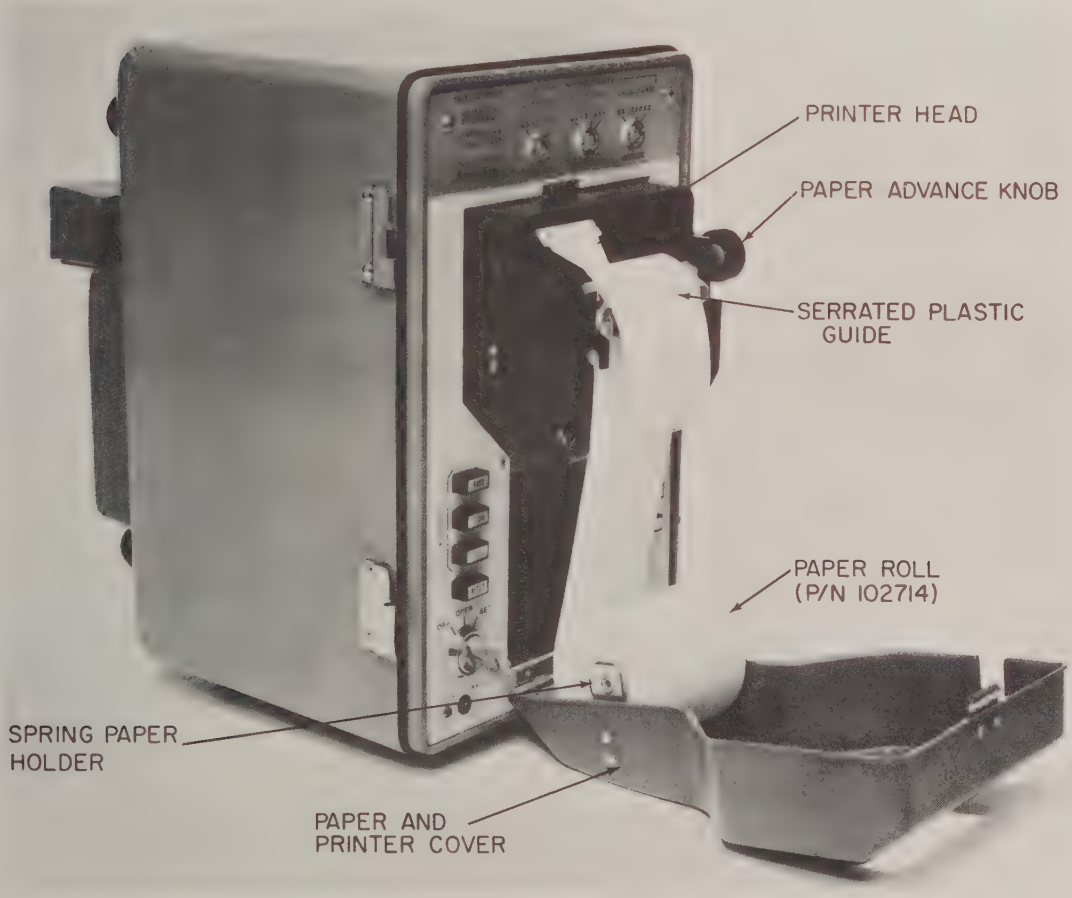


Figure B-2. Installing Paper Tape in Earlier Thermal Printers

DRANETZ
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CN-91

010080013

Date of Issue: October 13, 1980

PRINTER PAPER REORDER FORM

The Series 606-616, SER System 22, and 3100 use specially treated thermal paper. This paper is supplied direct from the factory by Dranetz Engineering Laboratories (P/N 102,714). Use of non-approved suppliers is not recommended as possible damage to the printer could result.

To insure rapid handling of your order, Dranetz Engineering Laboratories, Inc. has established two alternative plans for reordering printer paper. These are described below. Please check the plan you prefer and provide the necessary information. Return this form in the self-addressed envelope enclosed. Shipment will be within 48 hours of receipt of order.

STANDARD REORDER PLAN

Minimum quantity is 27 rolls.
Price is $2.70/roll.
FOB, destination, Continental U.S.
Send a purchase order specifying P/N 102,714, shipping address, and billing address, if different.
You will be billed according to standard Dranetz Engineering Laboratories, Inc. procedures.

RAPID REORDER PLAN

Minimum quantity is 6 rolls.
Quantity:_____rolls at $2.70/roll.
FOB destination, Continental U.S.
Total payment enclosed $_____.
A check or money order in the above amount must be enclosed.

Ship paper to:

_____

_____

_____

Prices above subject to change, confirm prices at time of order with Dranetz Plant Sales Department or designated representative.

President's "E" Award

Series 616 Portable DC/AC Voltage Disturbance Analyzer

Monitors both DC & AC voltage levels simultaneously.

Classifies, analyzes, stores & prints out voltage-disturbance information.

Measures impulses, sags & surges, & slowly changing average levels.

DRANETZ

Worldwide Leadership in
Precision Impedance/Phase/Power Instrumentation

What the Series 616 Does...

The Series 616 monitors both DC and AC input voltage levels simultaneously and classifies, analyzes, stores and prints out information on three types of voltage disturbances: IMPULSE, SAG or SURGE, and SLOW AVERAGE.

Important Features...

MONITORS AC AND DC SIMULTANEOUSLY. Perfect to pinpoint the effects of AC line disturbances on the DC outputs of power supplies in computers, communication equipment, and medical instrumentation.

PORTABLE OR PERMANENT INSTALLATION. The 616, which fits under commercial airline seats, is ruggedly constructed to prevent damage during transport. Once connected to a power line, the instrument can operate unattended for months. After 100 days, an internal day counter resets to zero, then starts over.

NO WASTED PAPER. The 616 operates only on disturbance or command. Paper consumption therefore depends only on the number of disturbances or frequency of testing. With the thermal printer, there is no need to replace ink or ribbons.

IMMEDIATE AND SUMMARY MODES. Individual events are each recorded at the time of occurrence. At midnight, the 616 summarizes the day's events automatically. Or a summary is printed any time on manual command. When disturbances occur during printing, the instrument stores the first 15 events, or hits, then prints out full information in sequence when the printer is free. After 15 hits, the 616 stores disturbances (up to 4000 of each type) for later printing in summary form. With the printer off, individual events are not recorded, but the summaries are still available for later printing.

POWER INTERRUPTION STANDBY. When the 616's own power line falls below the specified minimum (90 V) for more than 0.5 s, the 616 goes into a standby mode for four hours or until power returns. The printer records a POWER OFF message and time. Internal batteries maintain the data memories and the clock, but printer and detector operation cease. Optional: two hours of full operation during total power interruption.

Where the Series 616 is Used...

The 616's unique ability to monitor AC and DC simultaneously makes the instrument ideal for analytical evaluation of power-conversion equipment. The 616 is especially aimed at line-sensitive equipment used in such crucial areas as computation, process control, communications, and medicine. Typical applications include:

- **Field Troubleshooting.** It is not sufficient merely to identify disturbances on the AC input to a power supply. Rather, it is essential to prove that the AC input disturbance caused a disturbance in the DC output and, therefore, contributed to an equipment malfunction. The Series 616 provides this correlation.
- **Testing Power Conditioning Equipment.** Measure the effect of transients, dropouts, and other disturbances on the proper internal functioning of voltage regulators and UPS systems.
- **Monitoring Battery Voltages.** Detect troublesome disturbances on the DC battery voltages used in electric utility substations and in telephone central offices.
- **Power Supply Life Testing.** Determine whether failures or "out-of-spec" performance are caused by disturbances on the AC input to the life test rack.
- **Transient Throughput Analysis.** When designing power supplies, measure the response of DC output levels to transient disturbances on the AC input.
- **Output/Input and Output/Output Interaction Analysis.** Measure the effects of output load variations on other DC output levels and the AC input voltage.
- **DC Current Monitoring.** Using suitable current probes, measure and record disturbances in current.

How the Series 616 Works...

DC inputs are converted to AC in precision inverters. Individual detectors monitor the resultant AC, as well as the AC channel input, for deviations that represent sags or surges, slow-average variations, or impulses. The detector outputs are scanned, digitized, and presented to the microprocessor, which also has access to preset threshold values. If the microprocessor decides that a disturbance has occurred, it analyzes the important parameters and directs a printout of the time of day, channel designation, type and amplitude of disturbance, and the duration in cases of SAG/SURGE and SLOW AVERAGE.

To avoid data loss during printing, the 616 stores all information on up to 15 disturbances that may occur during a print out. After 15 disturbances, the instrument continues to accumulate data, but in summarized form. When the printer is free, the 616 prints the 15 disturbances in sequence, followed by the summarized information.

The 616 also places all printed information into memory. At midnight, the instrument automatically prints a summary of all data collected during the previous 24 hours, and then clears its memory. Or you can press a button at any time to receive the summary without clearing the memory.

Manufactured under U. S. Patent Nos. 3,549,874; 4,187,461; 4,206,413.
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Data Printout

STORED DISTURBANCES:
If line disturbances occur during data printout, full information on up to 15 sequential disturbances will be stored in the instrument's memory, and printed out in proper sequence when the printer is free.

ACCUMULATED COUNT, SHORT-TERM MODE:
When the number of stored disturbances (see above) reaches 15, the microprocessor will switch to a short-term accumulated count mode, and will store summarized information. The return of stable conditions will be followed by a printout, for each channel, of the following additional information:

a. Time of stable condition.
b. New value of Slow Averaged Steady-State voltage.
c. Highest Slow Averaged Steady-State voltage that occurred in the interim.
d. Lowest Slow Averaged Steady-State voltage that occurred in the interim.
e. Highest SURGE voltage, and the total number of SURGE occurrences in the interim*.
f. Lowest SAG voltage, and the total number of SAG occurrences in the interim*.
g. Highest IMPULSE voltage, and the total number of impulses that occurred in the interim*.

SLOW-AVERAGED LEVEL:
The Slow-Averaged, Steady-State level measurement is the value of the monitored voltage (RMS calibrated for channel A) measured with a detector having a settling time of approximately 10 seconds. Each time the monitored voltage increases or decreases from the previously recorded value by more than the pre-selected threshold, the instrument will record the channel, time, voltage level, and AVG+ or AVG—, indicating an increase or a decrease from the previously recorded Slow-Averaged, Steady-State value. Because there is no fixed voltage reference, setup under various AC and DC voltage conditions is greatly simplified.

IMPULSE:
Measuring circuits continuously monitor input during a cycle (based on channel A input frequency) sampling periods (T_S), measuring and holding the highest peak value of transient impulses having a duration between 0.5 and 800 μs. At the end of T_S, the microprocessor analyzes these data and resets the measuring circuits for the ensuing period T_S. If one or more impulses exceed the pre-selected threshold setting during any sampling period, the instrument prints channel designation, time, peak value of V_{imp} (excluding the instantaneous AC or DC level) and the word IMPULSE.

SAG/SURGE
Sags and surges are sudden negative or positive changes in the level of the monitored voltage, but of longer duration than impulses. The instrument averages the voltage level over one interval (one cycle of channel A input), and compares each measurement with the slow-averaged steady-state value at that instant. If the single interval measurement is higher, the instrument recognizes a SURGE; if lower, it recognizes a SAG. If the change in voltage exceeds the preselected threshold value, the microprocessor directs a printout of channel, time, maximum single-interval voltage (for SURGE) or minimum single-interval voltage (for SAG) followed by the designation SURGE or SAG, and the duration in number of cycles of the channel A input frequency.

*Only when such disturbance has exceeded the preselected threshold.

Typical Printout & Interpretation

IMPORTANT! Note that record emerges from instrument in the sequence indicated by the arrows.

Max. impulse on Channel C, 3.1 V, 6 impulse hits. –
Max. sag to 8.6 V on Channel C, 8 sag hits. –
Max. surge to 12.6 V on Channel C, 7 surge hits. –
Channel C avg., 10.7 V, at 18:11:48. –
Max. impulse on Channel B, 3.4 V, 14 impulse hits. –
Max. sag to 8.4 V on Channel B, 3 sag hits. –
Max. surge to 12.6 V on Channel B, 4 surge hits. –
Channel B avg. 10.4 V at 18:11:43. –
Max. impulse on Channel A, 488 V, 14 impulse hits. –
Max. sag to 97 V on Channel A, 6 sag hits. –
Max. surge to 146 V on Channel A, 2 surge hits. –
Min. steady-state of 115 V RMS on Channel A. –
Channel A avg., 121 V RMS, at 18:11:37. –

```
IMP 03.1V 0006 HTS
SAG 08.6V 0008 HTS
SUR 12.6V 0007 HTS
C 10.7AV 18:11:48
IMP 03.4V 0014 HTS
SAG 08.4V 0003 HTS
SUR 12.6V 0004 HTS
B 11.4AV 18:11:43
IMP 0488V 0014 HTS
SAG 097V 0006 HTS
SUR 146V 0002 HTS
LO = STORAGE 115
A 121V AV 18:11:37
SHORT TERM ACCUM
```

This shows the effect of a large number of rapidly occurring disturbances on all 3 input channels, beginning at 18:11:11. The series includes 3 + 14 = 17 IMPULSE hits on both Channels A and B, and 6 impulse hits on Channel C. There also occurred 5 + 6 = 11 SAGS, 3 + 2 = 5 SURGES on Channel A; 2 + 4 = 6 SURGES, 0 + 3 = 3 SAGS on Channel B; and 8 SAGs plus 7 SURGES on Channel C. Note that memory becomes overloaded after 16 hits. Thereafter, the microprocessor transfers information to the accumulator which (after the printer clears) produces the SHORT-TERM ACCUM printout above (at 18:11:37). Note that the SHORT-TERM ACCUM shows additional data that occur after the first 16 hits, but still within the overall recording interval.

```
0007 CYCLES
A 115V SURGE
0004 CYCLES
B 10.8V SAG
0006 CYCLES
C 11.5  SURGE
0008 CYCLES
A 134V SURGE
0005 CYCLES
B 11.2  SAG
0005 CYCLES
B 11.8  SURGE
0007 CYCLES
A 154V SURGE
0007 CYCLES
A 105V SAG
0002 CYCLES
B 03.6V IMPULSE
0007 CYCLES
A 0488V IMPULSE
B 03.0  IMPULSE
0006 CYCLES
A 102  SAG
A 0488V IMPULSE
B 03.4V IMPULSE
A 0488V IMPULSE
18:11:11
```

Steady-state voltage on Channel A has decreased to 115 V RMS at 13:39:12.

```
A 115V AVG -
13:39:12
```

DC level on Channel B has increased to 11.6 V at 13:38:17.

```
B 11.6V AVG +
13:38:17
```

272 V impulse on Channel A at 10:30:34.

```
A 0272V IMPULSE
10:30:34
```

2.5 V impulse on Channel B at 10:30:17.

```
B 02.5  IMPULSE
10:30:17
```

Impulse of 3.4 V on Channel B at 10:29:44. Another impulse, of 480 V, occurred on Channel A during printout, was stored, then printed out when printer was free.

```
A 0480V IMPULSE
B 03.4V IMPULSE
10:29:44
```

Surge to 11.8 V, duration 11 cycles, on Channel C at 10:29:30.

```
0011 CYCLES
C 11.8  SURGE
10:29:30
```

Sag to 9.7 V, duration 9 cycles, on Channel B at 10:29:21.

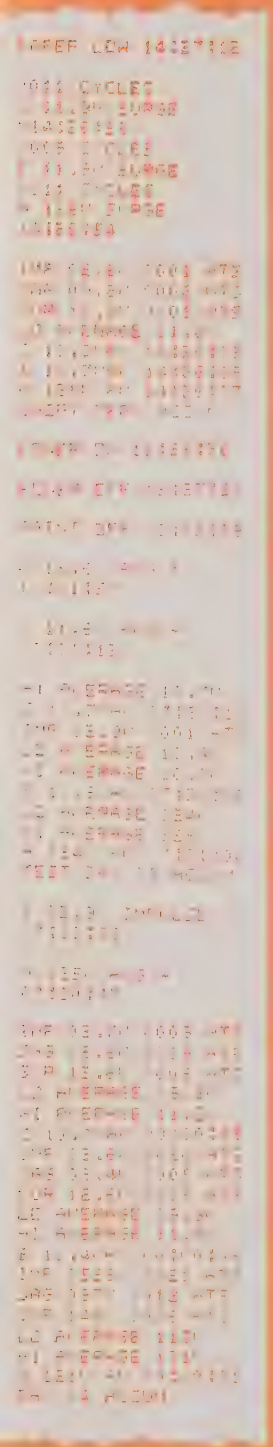
```
0009 CYCLES
B 09.7V SAG
10:29:21
```

Surge to 134 V, duration 7 cycles of line frequency, occurred at 10:29:03 on Channel A. Surge to 11.5 V, for 5 cycles of Channel A frequency, occurred on Channel B during printout, was stored in memory, then printed out as soon as the printer was free.

```
0005 CYCLES
B 11.5V SURGE
0007 CYCLES
A 134V SURGE
10:29:03
```

This record begins sometime during normal operation, *not* at turn-on of the instrument.

Record ends here.



At the conclusion of the preceding printout, a PAPER LOW was recorded at 14:27:12.

Almost simultaneous surges on channels A and B produced this record at 14:26:54. Channel A surged to 138 V for 11 cycles, B to 11.9 V for 9 cycles (of Channel A frequency). At 14:26:58, an external event (option 104) was recorded as noted by the "#" symbol, and Channel C surged to 11.9 V for 11 cycles.

Printer turned back on at 14:26:07, which immediately results in a SHORT TERM ACCUM report of disturbances that occurred while the printer was off . . . plus the usual report of present voltage level on each channel.

Supply power came back on at 12:28:16. Note 10-second delay while internal circuits normalize.

Supply power went off at 12:27:50.

Printer turned off at 10:02:09. Memory will continue to accumulate information, and printer will continue to print TEST ACCUM, DAY ACCUM, POWER OFF, and POWER ON, as required.

DC level on Channel C increases from 11.6 V at 10:01:13 to 12.6 V at 10:01:57.

Accumulated total for the day as of 07:31:04. Readout occurs when TEST button is depressed. Data are retained in accumulator memory. This printout always includes reports on the present voltage level of each channel.

2.9-V impulse on Channel B at 07:30:53.

Steady-state voltage on Channel A increased to 125 V at 7:30:47.

— Max. impulse 3.7 V, 9 impulse hits.
— Max. sag to 8.6 V, 9 sag hits.
— Max. surge to 12.6 V, 8 surge hits.
— Min. steady-state DC level of 9.8 V.
— Max. steady-state DC level of 11.2 V.
— Channel C, present voltage and time.
— Max. impulse 3.6 V, 20 impulse hits.
— Max sag to 8.4 V, 5 sag hits.
— Max. surge to 12.6 V, 8 surge hits.
— Min. steady-state DC level of 9.9 V.
— Max. steady-state DC level of 11.6 V.
— Channel B, present voltage and time.
— Max. impulse 528 V, 21 impulse hits.
— Max. sag to 97 V, 12 sag hits.
— Max. surge to 146 V, 6 surge hits.
— Min. steady-state of 115 V.
— Channel A, max. steady-state voltage of 131 V.
— Channel A, present voltage and time.
— At the start of day 5, the previous day's accumulated data are summarized, channel by channel.

Data Printout

FREQ+ or FREQ— (on Option 101 only):
Prints one-second average of frequency, and time of occurrence, if frequency on channel A deviates from previously printed frequency by more than a preselected threshold. Thresholds of 0.5, 1, and 2 Hz are selectable by a front-panel switch.

PAPER LOW:
When paper supply runs down to approximately 3 feet, this printout occurs as soon as printer is free. Instrument immediately goes into PRINT OFF mode, as described below, until new roll of paper is installed.

POWER OFF/ON (Interruptions of line power):
When the power line supplying the instrument is interrupted long enough to create the possibility of a malfunction, the symbol "POWER OFF," followed by the time of occurrence, is printed out. (See "Operation From Disturbed Lines," page 6.) Upon restoration of power for at least 10 seconds, "POWER ON" is printed, followed by the time of restoration.

PRINT OFF:
When the panel PRINT switch is placed in the OFF position, the words "PRINT OFF" and the time of occurrence are printed out. No further printing of disturbance information occurs. However, disturbance data are accumulated in the Accumulator, and can be printed out by pressing the TEST pushbutton. In addition, POWER OFF, POWER ON, and the daily accumulated count information are printed.

TEST MODE:
When the front-panel TEST pushbutton is pressed, the word "TEST" is printed, followed by the same information printout as described in Daily Accumulated Count' Mode, below. The Accumulators and Day Counter are not affected.

DAILY ACCUMULATED COUNT MODE:
At the start of each day, the following information is printed automatically for each channel:

a. Number of Day (0 to 99) and time.
b. New value of Slow-Averaged voltage.
c. Highest value of Slow-Averaged voltage in past 24 hours.
d. Lowest value of Slow-Averaged voltage in past 24 hours.
e. Highest SURGE voltage, and total number of SURGE occurrences in past 24 hours*.
f. Lowest SAG voltage, and total number of SAG occurrences in past 24 hours*.
g. Highest IMPULSE voltage, and total number of impulses in the past 24 hours*.

The Accumulators are then reset, and the Day Counter is advanced.

RESET MODE:
When the front-panel RESET pushbutton is pressed, the word "RESET" is printed, followed by the same information printout as described in Daily Accumulated Count Mode above. The Accumulators and Day Counter are then reset.

*Only when such disturbance has exceeded the preselected threshold.

The Series 616 at a glance...

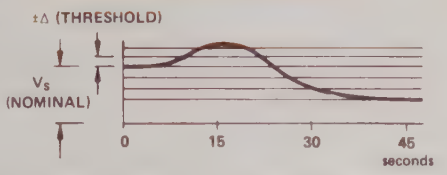
THREE INPUT CHANNELS (one AC, two DC)

Rear connections (with plastic safety cover) for up to three inputs. Transformer isolation on channel A for monitoring 50 or 60-Hz lines. Isolated DC inputs on channels B and C.

WIDE INPUT VOLTAGE RANGES

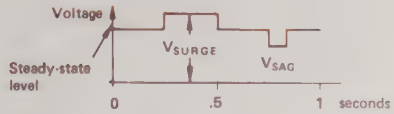
Nominal AC voltage input can range from 40 to 250 V RMS, 45 to 65 Hz. Nominal DC inputs range from ±4 to ±25 V*.

SLOW-AVERAGED RMS MEASUREMENTS



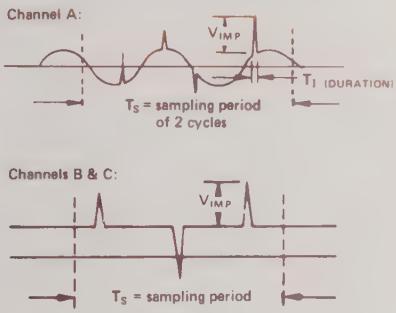
Slow average is a gradual, long-term change in average voltage level, with typical durations greater than several seconds.

SAG/SURGE MEASUREMENTS



Sag or surge is a sudden change in average voltage level, with typical durations between several milliseconds and several seconds.

IMPULSE MEASUREMENTS



Impulse is a brief voltage excursion, with durations between 0.5 and 800 μs.

PRINTED DISTURBANCE RECORD

Thermal printer gives a permanent record of each disturbance by time of occurrence, magnitude, duration and channel. No paper is wasted, since recording occurs only on disturbance or command. Data cannot be lost during printing.

AUDIBLE ALARM

Alarm sounds for one second when a disturbance threshold is exceeded. A relay contact closure, provided on the rear, is also activated.

DISTURBANCE SUMMARY

Concise record of disturbance activity is printed on command or automatically at the end of each day. Outstanding for survey work.

UNDER/OVER FREQUENCY MEASUREMENTS

Optional capability of monitoring variations in the AC line frequency.

PRECISE TIME CORRELATION

High-accuracy, crystal-controlled clock gives the time of occurrence of each disturbance in hours, minutes, and seconds. The clock can be set for real or system time. Ideal for correlating equipment malfunctions with voltage disturbances.

TAMPER-PROOF POWER SWITCH

Three-way, key-operated switch prevents accidental data loss or time disruption during operation. Left position is off. Right position starts operation. Center position permits key removal, and deactivates clock and reset switches, thereby ensuring tamper-free operation.

*For Model 616B, AC range is 80 to 500 V RMS; DC inputs range from ± 8 to ± 50 V.
For Model 616C, AC range is 80 to 500 V RMS; DC inputs range from ± 12 to ± 75 V.

Specifications...

VOLTAGE MONITOR MODES

Impulse: Measures and records peak value of impulse after filtering out AC waveform on Channel A, DC level on Channels B & C. Impulse durations range from 0.5 to 800 μs.

Sag/Surge: Measures and records cycle-to-cycle changes in RMS value of AC voltage on Channel A, and sudden changes in DC voltage level on Channels B & C (measurement interval equals one cycle of Channel A voltage waveform).

Slow Averaging: Measures and records slow changes in the steady-state AC voltage on Channel A, DC voltage level on Channels B & C (approximate averaging time is 10 s).

Accumulated Count: Records summary of disturbance information stored in memory. Printed out automatically at midnight (previous 24 hours), or on command by panel pushbutton.

INPUTS MONITORED (Connections on rear)

Channel A: Single transformer-isolated input, 2-wire, 50 or 60 Hz (45 to 65 Hz steady-state range).

Channels B & C: Two isolated inputs, 2-wire, DC, independent of polarity.

MONITOR INPUT VOLTAGE RANGES

Model (Channel)	Voltage Range	Steady-State Frequency Range	Maximum Impulse*	Input Impedance
616A (A)	40-250 V RMS	45-65 Hz	1000 V pk	100 kΩ
(B & C)	±4-25 V	DC	10 V pk	10 kΩ
616B (A)	80-500 V RMS	45-65 Hz	2000 V pk	200 kΩ
(B & C)	±8-50 V	DC	20 V pk	20 kΩ
616C (A)	80-500 V RMS	45-65 HZ	2000 V pk	200 kΩ
(B & C)	±12-75 V	DC	30 V pk	30 kΩ

THRESHOLD VOLTAGES (Selectable by front-panel switches)

	Model	Channel A	Channels B & C
Impulse	616A	50-100-200-400 V	0.5-1.0-2.0-4.0 V
	616B	100-200-400-800 V	1.0-2.0-4.0-8.0 V
	616C	100-200-400-800 V	1.5-3.0-6.0-12.0 V
Sag/Surge	616A	3-5-10-15 V rms	0.3-0.5-1.0-1.5 V
	616B	6-10-20-30 V rms	0.6-1.0-2.0-3.0 V
	616C	6-10-20-30 V rms	0.9-1.5-3.0-4.5 V
Slow/Average	616A	3-5-10-15 V rms	0.3-0.5-1.0-1.5 V
	616B	6-10-20-30 V rms	0.6-1.0-2.0-3.0 V
	616C	6-10-20-30 V rms	0.9-1.5-3.0-4.5 V

ACCURACY

Impulse (all channels): ±5% of reading ±1% of maximum impulse, calibrated with a positive-going, 10-μs, half-sinewave impulse. Typical single-impulse frequency response is ±1 dB for impulse widths from 10 to 50 μs, and ±6 dB from 0.5 to 800 μs, measured with half-sinewave impulses.

	Channel A (at 60 Hz)†	Channels B & C
Sag/Surge:	±1% of reading ±1% of nominal input	±1% of reading ±0.5% of max. input
Slow Average:	±1% of reading ±1% of nominal input	±1% of reading ±0.5% of maximum input

TIME CLOCK

Controlled by internal crystal oscillator. Crystal stability ±25 PPM (approximately ±2 seconds/day). Clock can be set to within 1 second using front-panel buttons. With power-switch key removed, the clock setting cannot be altered.

AUDIBLE ALARM

The Series 616 is equipped with a built-in audible alarm signal which can be disabled or placed in a 1-second signal-duration mode with a front-panel switch.

OPERATION FROM DISTURBED LINES

The 616 will operate properly with line disturbances on its own power line over the entire specified measuring ranges of impulses††, sags, and surges††. It will also operate properly during line-voltage interruptions of up to approximately 0.5 second.

For line interruptions exceeding 0.5 sec, the 616 will switch to internal batteries having the capability of maintaining the clock and memories for up to four hours of power-down operation. A POWER OFF message and time are printed.

Upon restoration of power for a full ten seconds, the 616 will shift back to its normal line-powered mode. POWER ON and the time are recorded.

For Operation During Long Power Outages: Model 910** Uninterruptible Power Supply provides complete battery backup for about 2 hours.

STEADY-STATE POWER REQUIREMENTS

90 to 140 V RMS, 45 to 65 Hz, single-phase, 1.0 A maximum.
(Also DC operation from 120 to 170 V maximum.)

TEMPERATURE RANGE:

+50° F to +113° F (+10° C to +45° C) operating;
−40° F to +130° F (−40° C to +55° C) storage.

DIMENSIONS AND WEIGHT

Instrument is housed in a portable case with removable cover, carrying handle, and rubber feet. 11" high x 7" wide x 11½" deep (28 cm. x 18 cm. x 30 cm.) including cover. Approximately 20 pounds (9.1 kg.). An optional 19" rack mount with dust covers is also available.

STANDARD OPTIONS AND ACCESSORIES

Consult factory for detailed specifications on these and other special adaptations of the Series 616.

Option 101
Under/Over Frequency monitoring on input channel A, with selectable thresholds of ±½, 1, and 2 Hz; ±0.25 Hz accuracy. The frequency is monitored over 1-second sampling periods. Printout indication of frequency changes exceeding selected threshold is "FREQ+" or "FREQ−".

Option 102:
Power operation either from 180 to 280 V RMS, 45 to 65 Hz, single phase, or from 90 to 140 V RMS, 45 to 65 Hz, single phase (switch-selectable).

Option 104:
Adds to the basic 616 an additional optically isolated, 2-terminal signal-input channel that accepts a 5 to 15 VDC external signal. Each application of such an external signal generates a time-mark entry and identifying symbol ("#" followed by the time in hours, minutes, and seconds) on the record printout. Can be used to enter, manually or automatically, a record of occurrences of any external event (such as an equipment malfunction) for use in subsequent analysis.

Option 105:
Adapts the Series 616 for use with Impulse Analysis Adaptors.

Option 106:
RS 232C data output.

Option 105/106:
Combination of Options 105 and 106.

Printer Paper (P/N 102, 714):
Approximately 140 feet x 2¼ inch wide rolls (2.5 inch diameter) of thermal paper. Consult the factory before substituting alternative types of paper.

Shipping Container (P/N 103, 100):
Fits any Model 616. Lined with custom-contoured foam padding. Container has steel-reinforced corners and a recessed carrying handle. Exterior dimensions, 10½" x 21" x 15" (26.7 x 53.3 x 38.1 cm.).

MR15 Series Rack Mounts
19" wide x 12¼" high (48.3 x 31.1 cm) rack-mounting panels with cutouts, mounting provisions, and dust covers for the Model 616 DC-AC Voltage Disturbance Analyzer. Three combinations are available:
MR15 — 1 — one Model 616
3 — two Model 616
5 — one Model 616 and one Model 910**

*Max. voltage for impulses having an effective duty cycle <1%.
†Based on sine wave signals.
††Surges limited to 140 V RMS and impulses limited to 1000 V pk.
**See Bulletin 606.

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1081-15M Printed

DRANETZ

PRODUCT CATALOG

PRECISION INSTRUMENTATION FOR

- Phase/Gain
- Impedance
- Current
- Voltage
- Quality Factor Q
- Time/Frequency
- Power Line Disturbance
- Sequence of Events
- Harmonic Power

DRANETZ

Worldwide Leadership in Precision
Impedance/Phase/Power Instrumentation

INTRODUCTION

DRANETZ ENGINEERING Laboratories, Inc. is a leader in the design and manufacture of precision AC test instruments and systems. This equipment is widely used for measurement of impedance, admittance, transfer function, voltage, current and phase.

THIS CATALOG contains complete descriptions and specifications on many Dranetz instruments. With current price lists, this information is sufficient for specifying and ordering equipment. Additional information is often available, including application notes as well as Bulletins describing specific instruments and systems. These can be obtained by contacting our main plant or your local field representative.

DRANETZ EQUIPMENT utilizes the latest developments in the electronics state-of-the-art to provide the most advanced equipment with high quality at an economical price. Each instrument utilizes the latest in solid state and microcircuit components and, where possible, uses modular design. Flexibility and versatility are designed into these instruments at their concept. Computer compatibility is often available in standard instruments, and options can be provided for special requirements. In addition, the plug-in concept of these instruments assures exceptional flexibility.

OUR HIGHLY TRAINED FIELD AND PLANT ENGINEERS are readily available to assist you or supply you with additional information to enable you to meet your specific requirements. A telephone call will bring this service to you immediately without cost or obligation.

AFTER SALE SERVICE is an important reason for purchasing Dranetz equipment. Each instrument is warranteed for 1 full year after purchase. Dranetz maintains technical field representatives throughout the U.S. and in other countries, fully backed by in-plant experts. Wherever possible, application and service problems are solved on site. In addition, the company provides prompt and immediate service for equipment returned from the field. Frequently loan equipment is available for use during equipment repair.

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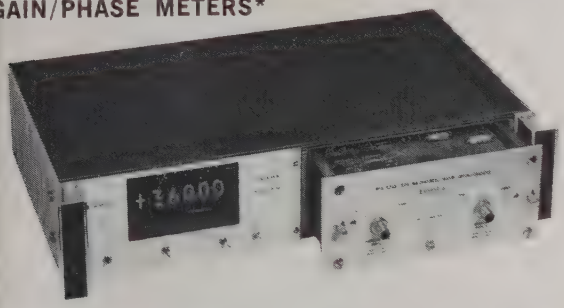
For information on products assigned Federal Stock Numbers (FSN) or available on Federal Supply Schedules (GSA) please contact factory.

DRANETZ

SERIES 305

SUPER PERFORMANCE PHASEMETERS AND GAIN/PHASE METERS*



305 Series Phasemeters provide the highest available accuracy, along with many operational features. Designed for the calibration laboratory, the design engineer's bench, the production line and automatic test systems, the 305 is the most widely accepted phasemeter in industrial, and governmental organizations. **

FEATURES

- No hands 86 dB dynamic range
- Automatic or programmable operation and calibration
- Highest accuracy — to 0.03°
- Repeatability better than 0.01°
- Rejects harmonics and noise
- Wide frequency range — 1 Hz to 11 MHz
- IEEE 488 Bus Compatibility

FLEXIBILITY THROUGH PLUG-IN CONCEPT

The plug-in concept of the 305 offers a wide selection of characteristics. Three standard mainframes and nine plug-ins are complemented by a variety of options, such as programmability, high speed and autocalibration. Special modifications are also available. In addition, modular construction throughout provides maintainability at both component and P.C. card levels for ease and speed of servicing.

WIDE FREQUENCY RANGE

The basic mainframe provides a direct frequency coverage of 2 Hz to 700 kHz with high accuracy. By the use of frequency converting plug-ins such as the 305-PA-3005, standard units can handle frequencies up to 11 MHz. Special units can be provided for higher frequency.

NO HANDS OPERATION

The Series 305 Phasemeters require no controls or adjustments by the operator. These units are also equipped with several significant automatic features. These include automatic selection of angle range, automatic sensing of leading or lagging angle, automatic selection of the output time constants, and automatic setting of AC gains.

HIGHEST ACCURACY

Accuracy to better than ±0.03° is attained with precision mainframes and carefully designed plug-ins. Mainframes exhibit precise zero crossing detection, angle-to-DC conversion linearity to approximately ±0.01° and outstanding DC stability. Plug-ins are designed for accurate conversion of sine wave (also square wave) inputs to square waves through carefully controlled amplifier circuitry, use of gain autoranging, and harmonic filters where necessary.

INSENSITIVITY TO INPUT LEVEL

Series 305 plug-ins are available with a guaranteed accuracy of better than ±0.05° even with independent input level variations of 60 dB. Typical accuracy can approach ±0.03° as shown on the following page.

NON-AMBIGUOUS ANGLE READINGS

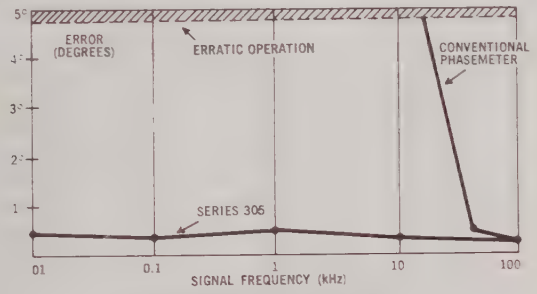
Two phase angle ranges in the 305 eliminate the ambiguity or "dead zone" error inherent in all other phasemeters (usually at 0°/360° or −180°/+180°). An automatic system switches to the 0°/360° range for angles near 180° and to the −180°/+180° range for angles near 0°. Unique guard bands prevent dead zones near switching points.

REPEATABILITY, STABILITY, AUTOCALIBRATE

Repeatability of the 305 is better than ±0.005°; temperature coefficient is ±0.001°/°C; and DC output drift is better than ±0.05° over any 30 day period. The autocalibrate feature eliminates virtually all DC errors in digital panel readout and BCD rear panel outputs.

NOISE IMMUNITY

Unique patented circuitry minimizes noise errors and makes possible accurate phase measurements under noise levels where other phasemeters become completely useless. The accompanying curve compares the phase error of the model 305 with that of a conventional phasemeter with broad band noise in both channels.



PHASE READING ERROR VS SIGNAL FREQ FOR GAUSSIAN NOISE (FLAT TO 5 MHz IN BOTH CHANNELS FOR S/N = 10

PROGRAMMABLE OPERATION

Standard mainframes are provided with rear connections for overriding the automatic time constant and angle range selectors by relay contact closures. Options are available for full compatibility with IEEE 488 Interface Bus and for control by DTL and TTL logic.

DIGITAL READOUT

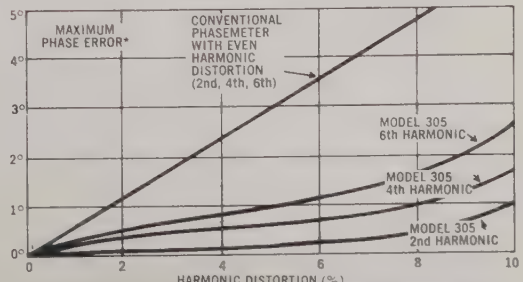
In addition to analog DC output, standard mainframes are available with up to 5 digit panel readouts (i.e., 0.00° to ±180.00° and 0.00° to +360.00°) and BCD outputs for each digit. Autocalibrate feature eliminates virtually all meter drift and scaling errors.

RAPID PHASE NULLING

For production testing of filters and other networks, an additional analog deviation-panel meter (305D) provides an easy means of adjusting a test angle to any accurate value. Presetting can be done in seconds without any other equipment. The precision digital panel meter monitors actual test angle continuously.

ABILITY TO REDUCE HARMONICS

The 305 is designed to reduce significantly the errors due to even harmonic distortion without the use of filters. The accompanying curve compares the error due to even harmonic distortion (maximized for worst case harmonic angle) on conventional phasemeters and on the model 305. (Odd harmonics in-phase with fundamental contribute no error.)



COMPARISON OF ERRORS DUE TO EVEN HARMONIC DISTORTION
(* For worst case phase relationship between harmonic and fundamental

*Manufactured under U.S. Pat. No. 3,725,781
**For extensive application information, write for availability of "Applications Handbook of Precision Phase Measurement."

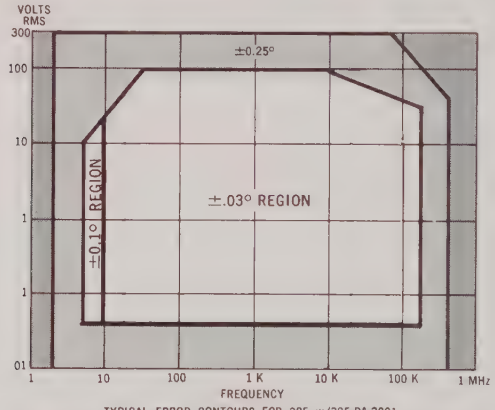
SERIES 305

SUPER PERFORMANCE PLUG-INS

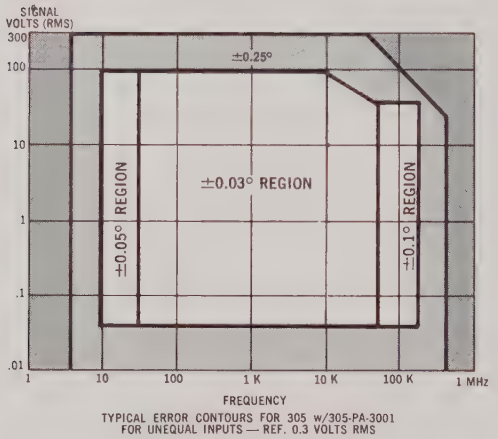
The variety of plug-ins available provides unlimited flexibility for the Series 305 Phasemeters in meeting many phase measurement problems. In addition to an expanding line of standard plug-ins, custom units can be designed for special needs.

305-PA-3001 AUTORANGING PLUG-IN

This plug-in features high accuracy over a broad range of input levels and frequencies. Autoranging of gain in each channel assures high accuracy (±0.05° guaranteed) over a dynamic range of 60 dB (50 mV to 50 V rms) for independent levels of inputs, with a useful range of 90 dB (10 mV to 300 V rms). This plug-in covers the range from 2 Hz to 700 kHz, with its highest accuracy in the 50 Hz to 50 kHz range. The curves shown illustrate typical accuracies as a function of level and frequency. The 305-PA-3001 also features compatibility with Tektronix probes and includes front panel lamps to indicate when either input signal is below 50 mV or above 50 V rms.



TYPICAL ERROR CONTOURS FOR 305 w/305-PA-3001 FOR EQUAL SIGNAL INPUTS



TYPICAL ERROR CONTOURS FOR 305 w/305-PA-3001 FOR UNEQUAL INPUTS — REF. 0.3 VOLTS RMS

While the above accuracies apply to sine wave inputs, this instrument can also be used for square wave and amplitude modulated signals.

305-PA-3002 SINGLE RANGE PLUG-IN

The 305-PA-3002 is similar to the model 305-PA-3001 except that it does not include autoranging or limit indicator lamps. For sine wave inputs the standard unit is designed for guaranteed ±0.05° accuracy (typically ±0.03°) over independent signal levels of 50 mV to 500 mV rms, with a slight reduction in accuracy from 10 mV to 3 V rms. Other level ranges can be supplied on special order; Tektronix probes can be used for high input levels. This plug-in is useful for sine wave, square wave and amplitude modulated signals.

305-PA-3005 HIGH FREQUENCY PLUG-IN

This high frequency plug-in is designed for high accuracy to 11 MHz. Using a self tracking oscillator, the input signals are converted to 40 kHz for precision measurement by the mainframe. Input attenuators (50 ohms) are provided with 10 dB steps, to cover a range of 1 mV to 3 V rms in either channel. Front panel lamps indicate when input levels are out of range or when level controls are improperly set. The self tracking oscillator can be controlled by channel A signal or by a third independent signal.

305-PA-3007 PROGRAMMABLE AND AUTORANGING PLUG-IN

This programmable plug-in features all of the characteristics of the model 305-PA-3001. In addition it includes increased input gain to achieve operation down to 1 mV rms. The unit can be operated either in an automatic or programmable mode. Without rear connections, the plug-in operates automatically as a 305-PA-3001; however, by utilizing rear connectors, the internal autoranging can be overridden and additional internal gain can also be inserted. Programming is available by DTL and TTL logic.

305-PA-3008 SINGLE FREQUENCY PLUG-IN

The 305-PA-3008 is a special purpose plug-in designed for precision calibration of 50 Hz, 60 Hz and 400 Hz power line equipment such as wattmeters, phase detectors and watt hour meters. This instrument can measure phase difference between two voltages, two currents or between a voltage and a current. The unit covers a voltage range of 25 V to 250 V rms and a current range of 0.1 to 5 A rms. The basic plug-in covers the frequency range of 50 Hz to 500 Hz. Plug-in filters, available for 50 Hz, 60 Hz and 400 Hz, assure reduction of second harmonic by at least 40 dB and higher harmonics by at least 50 dB. A front panel zero control provides adjustment for high accuracy (±0.1°) at any single frequency.

305-PA-3009 WIDE BAND NETWORK ANALYZER PLUG-IN (GAIN/PHASE/AMPLITUDE)

This plug-in measures the voltage amplitude of each signal input (in volts or dBV, selectable by operator), the phase difference between inputs, and the amplitude ratio of inputs. Featuring autoranging of gain in both channels, it requires no manual setting of gains for any measurement. Simultaneous DC outputs on mainframe are proportional to all four fuctions. A front panel switch selects the measuring mode for digital panel readout — channel A voltage, channel B voltage, phase difference, or amplitude ratio. Lamps on the front panel of the plug-in indicate the proper decade multiplier. The 305-PA-3009A is designed for extending the low frequency range.

305-PA-3010 SPECIAL PURPOSE PLUG-IN

This plug-in is typical of special purpose plug-ins which can be supplied to meet unique problems. Having high input impedance, it is equipped with closely matched low pass filters to pass 125 Hz signals while rejecting 400 Hz signals, solving problems in many types of servo control systems. Similar units can be readily designed for other special voltage and frequency applications.

305-PA-3015 PROGRAMMABLE PLUG-IN

Intended for use in automatic test systems, this plug-in has two selectable filters for harmonic rejection and selectable gains to handle inputs from 50 mV to 50 V rms. Filter (or filter out) selection as well as gain switching is accomplished by contact closures across terminals on the rear of the main frame.

PRECISION TRANSFORMER ISOLATION NETWORKS

Dranetz TR 3100 series networks are available for input voltage isolation with minimum phase error and flat gain response. For use with balanced or signal ended sources, these units are equipped with internal preamplifiers to produce outputs in the 30 mV to 3 V rms range (for use with 305 Series Phasemeters) for input levels from 50 mV to 500 V rms. These transformer units are packaged for direct plug-in into the input BNC's of the phasemeter, and draw B+ power from the front panel accessory connector of the phasemeter plug-in. Size: 2¾" x 2¾" x 2". Input: banana jack. Output: BNC.

Model TR___	Zin	Com. Mode Rej: >60 dB for frequency	Range for ±0.1° typical shift	Range for ±0.3° typical shift	Gain ±2%
3101	1 megΩ 70 pF	Below 1 kHz	20-400 V rms 50 Hz-20 kHz	5-400 V rms 10 Hz-25 kHz	x 0.01
3102	100 kΩ 70 pF	Below 10 kHz	2-40 V rms 50 Hz-20 kHz	0.5-40 V rms 10 Hz-25 kHz	x 0.1
3103	10 kΩ 70 pF	Below 25 kHz	0.2-4 V rms 50 Hz-20 kHz	0.05-4 V rms 10 Hz-25 kHz	x 1.0

MAINFRAME SPECIFICATIONS

Frequency Range: 2 Hz to 11 MHz (see plug-in data)

Angle Ranges: 0.00° to ±180.00° or 0.00° to +360.00° manually or automatically selected. End-of-range measurement errors are prevented by 15° automatic guard zones.

Analog Output

Range: −1.8000 to +3.6000 Vdc corresponding to measured angle; 10.0 mVdc per degree

Accuracy: See plug-in specifications

Output Impedance: 100 ohms

DC Resolution: Infinite

Linearity: Approx. ±0.01°

Repeatability: Better than ±0.005°

Time Constants: Automatically selected; 10 ms for frequency >5 kHz, 50 ms >500 Hz, 350 ms >50 Hz, 700 ms >2 Hz (Note: 4.6 time constants to respond to better than 99% of step change).

Warm-up Drift: Approx. 0.05° after first minute.

Long Term Drift: Typically less than ±0.05° per month

Temp. Coefficient: Approx. ±0.001°/°C

Recommended Output Devices: Recorders, DVM's, A-D Converters, Printers

Self Check: Front panel switches; dc outputs correspond to −180.00°, 0.00°, +180.00° and +360.00°

Error Rejection: False triggers due to high frequency noise are locked out for signal to noise ratios better than 10:1. Errors and fluctuations due to waveform dissymmetry or low frequency noise reduced by at least 10 to 1.

Harmonic Rejection: Worst case errors due to even harmonic distortion reduced by approximately 5:1 without filters. Odd harmonics in-phase with fundamental contribute no error.

Operator Adjustments: None.

Operating Temp. Range: 0° to +50°C

Grounding: Independent grounds for signal, chassis, and power line. (For safety, chassis and power line grounds connected at factory.)

Remote Programmability (standard on all mainframes): By rear connector pins. Override by contact closure of automatic time constant selection and angle range. Factory installed wiring from rear connector to plug-in for use with programmable plug-ins.

Modular Construction: Circuits on removable plug-in cards, extenders supplied for ease in servicing.

Size: 3½" high, 16" deep, 19" rack/portable package; shipping 22½" x 22½" x 6½".

Weight: 20 lbs. (9 kg.); shipping 30 lbs. (14 kg.).

Power: 115/230 V, 50-400 Hz, <0.75 A (specify voltage and frequency when ordering).

Plug-In Accommodation: Accepts 305-PA-( ) plug-ins. Mainframes and plug-ins are interchangeable.

ANGLE PRESENTATION

	Model 305	Model 305B	Model 305C	Model 305D
DIGITAL				
Display	None	4 digit plus sign	5 digit plus sign	
Angle Ranges	Not Applicable	0.0° to ±180.0° and 0.0° to +360.0°	0.00° to ±180.00° and 0.00° to +360.00°	
Resolution	NA	0.1°	0.01°	
BCD Output	None	BCD coded (1248), 4 lines per digit plus polarity line; TTL/DTL compatible (<0.8 V to > +2.4 V dc). Read and hold on command, and data ready features available on rear connector.		
Warm-up Time	NA	30 minutes (1 minute with option 107)		
Zero & FS Controls	NA	Front panel for FS & 0 (no adjustments with option 107)		
ANALOG				
DC Output	10.0 mV/°; 0.0000 V to 3.6000 V and −1.8000 V to +1.8000 V corresponding to 0.00° to 360.00° and −180.00° to +180.00°; infinite resolution.			
DC Offset	None		Continuously adjustable angle offset. Analog panel meter and DC output indicate deviation from offset.	

OPTIONS

#101 Rear connectors for signal and reference inputs, BNC[4]

#102 Full mainframe programmability; includes self check, angle range and time constant selection, DTL and TTL compatible.

#103 High speed analog output response. Time to respond to within 99% of step change: 1 ms for frequency >5 kHz, 10 ms >500 Hz, 100 ms >50 Hz, 1 second >5 Hz. (Temp. stability ±0.01°/°C)

(Opt. 103 not available with Opt. 107 or Mod. 14 below.)

#105 Remote zero control.

#107 Automatic calibration checks and automatically readjusts digital readout and BCD output circuits to reduce readout errors to ±0.02°. This option available only on 305C.

#110 Full compatibility with IEEE 488 Interface Bus. (Requires options 102 and 305-PA-3007 Plug-In.) This option available only on 305C.

Mod. 14 Higher accuracy below 12 Hz. Available only on 305B, 305C, and 305D.

COMBINED PLUG-IN AND MAINFRAME SPECIFICATIONS

MODEL	FREQUENCY RANGE	INPUT LEVELS (independent)	INPUT Z	ACCURACY[2] WITH INDEPENDENT LEVELS UNLESS OTHERWISE INDICATED Analog output accuracy: As specified below. Digital phase accuracy: For model 305C, same as analog accuracy. For model 305B, add ±0.15° digital readout error to analog accuracy specified.
305-PA-3001 Auto Ranging Plug-in	2 Hz to 700 kHz	10 mV to 300 V rms up to 10 kHz and to 50 V rms up to 700 kHz; can be extended to 40 kV rms with Tektronix probes. Each channel has automatic gain ranging, and lamps which indicate when level is below 50 mV and above 50 V rms.	1 megohm shunted with 40 pF	+0.05°, 50 mV to 50 V rms from 50 Hz to 50 kHz; typically ±0.03°, 50 mV to 50 V rms from 50 Hz to 50 kHz, ±0.05° to 10 Hz, ±0.1° to 250 kHz, and ±0.25° at other levels to 500 kHz.
305-PA-3002 Single Range Plug-in	2 Hz to 700 kHz	10 mV to 3 V rms[1]; can be extended to 3 kV rms with Tektronix probes. Other ranges available on request.	1 megohm shunted with 40 pF	±0.05°, 50 mV to 500 mV rms from 50 Hz to 50 kHz; typically ±0.03°, 50 mV to 500 mV rms from 50 Hz to 50 kHz, ±0.05° to 10 Hz, ±0.1° to 250 kHz, and ±0.25° at other levels to 500 kHz.
305-PA-3005 High Frequency Plug-in	200 kHz to 11 MHz	1 mV to 3 V rms; manual level controls in 10 dB steps. Lamps indicate when inputs are out of range or when level controls are improperly set.	50 ohms	Broadband with equal inputs above 10 mV rms: ±0.4° from 200 kHz to 4 MHz; ±1° from 4 MHz to 11 MHz. With independent levels above 10 mV rms: ±1° up to 4 MHz and ±2° up to 11 MHz. Single frequency — above 10 mV rms: ±0.3° at any frequency from 200 kHz to 11 MHz at any fixed levels.
305-PA-3007 Programmable and Auto-Ranging Plug-in	2 Hz to 700 kHz	Autoranging: similar to levels of 305-PA-3001. Programmable: overrides autoranging; extends low levels to 1 mV rms; DTL, TTL logic; program connector in rear of mainframe.	1 megohm shunted with 40 pF	Same as 305-PA-3001 for levels above 10 mV rms; typically ±0.35° from 50 Hz to 50 kHz for levels below 10 mV rms.
305-PA-3008 Power Freq. Plug-in	50-500 Hz without filters. 50 Hz, 60 Hz and 400 Hz L.P. filters available[3]	25 V to 250 V rms; 0.1 A to 5 A rms. Inputs are transformer isolated.	100 k ohm (voltage) 0.02 Ω max. (current)	At any single frequency, with filter set: ±0.1°, 25 V to 250 V rms, or 0.1 A to 5 A rms.
305-PA-3009 Network Analyzer (Gain/Phase/ Amplitude)	5 Hz to 700 kHz (Note: 305-PA-3009A operates to 1 Hz with 305 mod. 14)	10 mV to 40 V rms. Each channel has automatic gain ranging. Direct reading of phase angle, amplitude ratio and level of each input. Compatible with Tektronix probes.	1 megohm shunted with 40 pF	Phase: ±0.1° from 40 mV to 40 V rms from 50 Hz to 50 kHz; typically ±0.25° at all other levels from 5 Hz to 500 kHz. Voltage Amplitude: above 40 mV (channel A or B): ±2% reading ±0.03% FS, 50 Hz to 50 kHz; ±5% reading ±0.03% FS, 100 kHz to 500 kHz.[5] Ratio: ±0.5 dB, 50 Hz to 50 kHz; ±1 dB, 50 kHz to 500 kHz.[5]
305-PA-3010 Special Purpose Plug-in (with filter)	For use at 125 ±10 Hz; matched filters in both channels reject higher frequencies	500 mV to 5 V rms. Other ranges available on request.	1 megohm shunted with 40 pF	±0.1°, 500 mV to 5V rms; ±0.25°, 100 mV to 500 mV rms.
305-PA-3015 Selectable Filter Plug-in	5 Hz to 500 kHz without filters; uses 2 of type 305-PA-3008-( ) filters [3]; filter selection programmable	Ranges of 50-500 mV rms, 0.5 to 5 V rms, and 5-50 V rms selectable by remote contact closures.	1 megohm shunted with 40 pF	With filters, ±0.1° at fixed frequencies over all levels; without filters ±0.1° from 50 Hz to 50 kHz at all levels (typically ±0.03°), typically ±.25°, 5 Hz to 500 kHz.

[1] Can be provided for other voltage levels.

[2] For sinusoidal signal; can be used for square wave inputs over limited frequency range; can be used for amplitude modulated signals up to 97% modulation, depending upon model, level and frequency.

[3] 50 Hz filter, P/N 305-PA-3008-50; 60 Hz filter, P/N 305-PA-3008-60; 400 Hz filter, P/N 305-PA-3008-400. (Other frequencies available on request.)

[4] Available for use with 305-PA-3001, -3002, -3007 and -3010. Specify when ordering plug-in. [5] For higher accuracy below 50 Hz, specify Model 305-PA-3009A.

DRANETZ

SERIES 331

HIGH ACCURACY ECONOMY PHASEMETERS

- Accuracy to 0.05°, resolution to 0.01°
- Frequency range 5 Hz to 500 kHz
- Analog output and 4 or 5 digit panel readouts
- Input 0.05 to 220 V rms
- Accepts sine, square and other waveforms in either channel

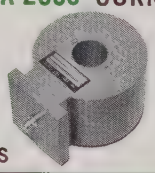
The Dranetz 331 Series Phasemeters feature high accuracy over a broad amplitude and frequency range. Front panel controls (equipped with LO/HI indicators) are used to select proper voltage ranges, as well as to check and adjust calibration. The 331 incorporates several of the important features of the Superperformance 305 Series, including elimination of 0°/360° ambiguity and reduction of sensitivity to noise and even harmonics. The 331 is designed for calibrating equipment, for testing subassemblies and for general laboratory work.

SPECIFICATIONS

CHARACTERISTICS	331B	331C
Frequency Range:	5 Hz to 500 kHz	
Accuracy: Sine Wave:	±0.1° ±1 digit from 50 Hz to 50 kHz, add ±0.2° per 100 kHz above 100 kHz and ±0.2° ±1 digit at 5 Hz.	±0.05° from 50 Hz to 50 kHz; ±0.2° from 10 Hz to 100 kHz; add ±0.2° per 100 kHz above 100 kHz.
Square Wave:	±0.1° ±1 digit from 10 Hz to 20 kHz; ±.5° per 100 kHz above 20 kHz	±0.05° from 10 Hz to 5 kHz; ±0.1° to 20 kHz; ±0.5° per 100 kHz above 20 kHz.
Angle Ranges:	000.0° to 360.0° or −180.0° to +180.0° automatic or selectable.	
Input Signal Amplitudes:	0.05 to 220 Volts rms in 3 ranges (0.05-0.5, 0.4-5, 4-220; can be extended with Tektronix probes.	
Input Impedance:	1 megohm shunted by 50 pF nominal	
Analog Output:	0.0000 to 3.600 V and −1.8000 to +1.8000 V DC, +10.00 mV DC/degree phase; output impedance less than 100 ohms.	
Ambient Temperature	0°C to 45°C	
Panel Controls and Adjustments:	3 range input level pushbuttons each channel; read-hold; power; 0° cal and 360° cal adjustments.	
Power Requirements:	105-125 or 210-250 volts, 50/60 Hz, 70 watts.	
Dimensions:	3½″ high x 16″ deep, 19″ rack/portable package; 22½″ x 22½″ x 6½″ shipping; 18 lbs. (7 kg) net wt., 25 lbs. (10 kg) shipping.	
Option:	#101: BCD output, TTL/DTL, 8421 — #102: Rack Mount	#101: BCD output, TTL/DTL, 8421 — #102: Rack Mount

FOR FULL INFORMATION AND DETAILED SPECIFICATIONS WRITE FOR BULLETIN 331

TR-2004 — TR-2005 CURRENT TRANSFORMERS



FEATURES

- Output voltage is faithful reproduction of input current
- Wide frequency and dynamic range
- Excellent pulse and phase response
- High voltage isolation
- 1¼″ D hole for primary

APPLICATIONS

- Testing sonar projectors and arrays
- High power immitance and transfer measurements
- Measuring transients in SCR's
- Measuring electron beam currents
- Current sensing in AC feedback systems

SPECIFICATIONS

CHARACTERISTIC	TR 2004	TR 2005
Sensitivity per Primary Turn (V rms/A rms)	0.1; +0, −1%	1.0; +0, −1%
Square Pulse Input		
Max. Current	10,000 A pk	1,000 A pk
Rise Time	For rise times > 1 microsec.	40 nanosec. approx.
Droop	10^{-4}%/microsec.	10^{-2}%/microsec.
Max. Amp-sec. per pulse	1	0.1
For Sinusoidal Input		
Amplitude Limit	100 A rms above 17 Hz; 9 A pk/Hz below 17 Hz; 90 A pk at 10 Hz	10 A rms above 100 Hz; 0.15 A pk/Hz below 100 Hz; 7.5 A pk at 50 Hz
Useful Frequency Range	0.25 Hz to 700 kHz	20 Hz to 10 MHz
Amplitude Response with Frequency +0%, −1% Limits		
Low Frequencies	4 Hz to 100 kHz 3 dB at 0.25 Hz	1 kHz to 4 MHz 3 dB at 20 Hz; −3% at 200 Hz; −5% at 100 Hz
High Frequencies	3 dB up to 700 kHz; +2.5% at 300 kHz; +7% at 400 kHz	3 dB at 10 MHz
Phase Response ±0.8° Limit	20 Hz to 100 kHz	1 kHz to 2 MHz
Low Frequencies	1.5° at 10 Hz; 2.9° at 5 Hz	2° at 500 Hz; 4° at 250 Hz; 8° at 100 Hz; 13° at 50 Hz
High Frequencies	1.5° at 200 kHz; 2.2° at 300 kHz	2.7° at 5 MHz
Electrostatic Shielding With 1000 volts rms at 5 kHz on primary, secondary output corresponds to less than:	10^{-4} ampere turns through primary	10^{-5} ampere turns through primary
Maximum Insertion Impedance	0.0002 ohms	0.02 ohms
Maximum Voltage	15 kV pk surface to high voltage; 30 kV pk with primary insulation	
Typical Primary Capacitance	6 pF in oil; 3 pF in air	
Recommended Load	> 10,000 Ω in parallel with < 20 pF	
Dimensions	(approx) 5″ OD x 1¼″ ID x 2½″ high plus mounting flange (4 mounting holes on flange: ¾₁₆″ D on centers 1⅞₁₆″ x 2½″)	
Connector	BNC	
Weight	4 pounds approx.	
Shipping Weight	8 pounds approx.	

DRANETZ

SERIES 325

POWER SYSTEM POLYMETER / DUAL MEASUREMENT OF VOLTAGE, CURRENT, TIME, FREQUENCY

FEATURES

- Simultaneous measurement and display of two selectable parameters.
- Display of continuous, triggered or maximum readings.
- Full isolation of all inputs.
- Precision measurement of time interval in seconds or cycles.
- Large 0.6″ digital display.
- Precision frequency measurement optional.
- Portable for field use.
- A field instrument with laboratory accuracy.

The Series 325 is specifically designed for measuring key parameters in electric power systems. Simultaneous measurements of Voltage and Current, 2 Currents, 2 Voltages, Current and Time, and Voltage and Time may be made. Readings may be taken on a continuous basis, or the meter may be triggered to "freeze" readings at a specific time. Time may be measured either in seconds or cycles of the power line frequency. Timing and trigger inputs may be actuated from type A or B dry contacts or by AC or DC voltages. Special circuits assure positive triggering on first contact and prevent simultaneous start/stop conditions. Options and adapters are available for DC current, DC voltage, fast frequency measurement, low pass filters and BCD outputs.

APPLICATIONS

- Ideal for electric utility use.
- Testing of trip points on overcurrent, overvoltage, undercurrent, undervoltage, and underfrequency relays.
- With Model 314 Phase Angle Meter, ideal for impedance relays.
- Precision measurement of frequency.

SPECIFICATIONS

Frequency Range: 47-450 Hz. (25 Hz available on request.)
AC Voltage: 15 mV to 1000 V RMS, 1.5, 15, 150, 600 V FS, transformer isolated, 5000 ohms per volt.
AC Current: 1.5 mA to 100 A RMS, 0.15, 1.5, 15, 100 A FS, transformer isolated, .001 ohms insertion resistance.
Time Interval (2 ranges): 0 to 999.99 seconds in .001 second increments. 0 to 9999.9 cycles in 0.1 cycle increments.
Trigger Inputs: (Start and Stop) Contact closure, DC step voltage change, or AC input.
Accuracies: V, I, for 57-63 Hz ±0.25% reading ±0.025% FS, for 25-450 Hz ±0.4% reading ±0.04% FS; Time, ±0.003% reading ± last digit.
Out of Range: Display blinks when level is too high.
Measurement Modes: Continuous, triggered, and "hold maximum."
Dielectric Test: 4250 V RMS to ground from V and I terminals. 1600 V RMS to ground from trigger terminals. (Per ANSI-C39.5.) Also meets SWC test.
Power Supply: 95 to 140 or 190 to 280 V RMS, 47 to 450 Hz, 20 watts, International Universal type connector.
Operating Temp. Range: 10°F. to 110°F.
Size: Portable, weatherproof, with cover 11″ L x 7″ W x 9½″ D; without cover 11″ L x 7″ W x 7″ D (Panel 11″ x 7″); shipping 11″ x 14″ x 18″.
Weight: 10 lbs. (5 kg.); shipping 17 lbs. (8 kg.).

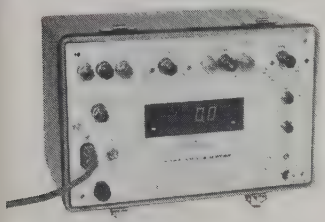
OPTIONAL FEATURES

Option 101: Fast frequency measurement capability — 0.1 sec. meas. time, 0.01 Hz resolution; 1 sec., .001 Hz resolution; accuracy ±0.002 Hz ± resolution.
Option Set 102 and 105: True RMS detection and low pass filters for removing effects of harmonics from measurements.
Option 103: BCD outputs suitable for driving printers for recording measured data. DTL/TTL compatible.
Option 107: Panel mount with remote display.
Option Set 108 and 109: Dry contacts corresponding to START/STOP times and accessory power for 325-PA-( ) adapters.
325-PA-1001: DC Current Adapter.
325-PA-1002: DC Voltage Adapter.
325-PA-1003: Contact Opening Trigger Adapter.
MR16-2 Rack Mount: 19″ rack plate and dust cover.

FOR FULL INFORMATION AND DETAILED SPECIFICATIONS WRITE FOR BULLETIN 325

SERIES 314

POWER SYSTEM PHASE ANGLE METER / FOR ACCURATE & RAPID MEASUREMENT OF PHASE ANGLE IN ELECTRIC POWER SYSTEMS



FEATURES

- Universal Current-Voltage Inputs, V-V, I-I, V-I
- Portable
- Immune to Harmonics
- Independent of Frequency Changes
- Digital Readout — "No Hands" Simplicity
- Accuracy ±0.5°, Resolution ±0.1°
- Independent of Input Levels
- Complete input isolation

APPLICATIONS

- Testing and Adjustment of Protective Relays
- Measuring Load Current Phase Angles — Measuring Power Factor
- Testing Polyphase Balance
- Determining Power Flow in Interconnected Systems
- Minimizing Circulating Reactive Currents
- Synchronizing Multiple Sources

Accurate, precise and rapid phase measurement is an essential technique in the setup, operation, and maintenance of modern power systems, subsystems, and the control and protection circuits used in them. The value of a phase meter in such applications is directly proportional to the speed, convenience, and validity with which it indicates the phase angles it measures. With the introduction of the Dranetz Model 314, virtually all of the limitations and error sources of electromechanical meters have been removed, and the overall accuracy of this class of phase measurements has been increased by more than a full order of magnitude. The basic accuracy of ±0.5° specified for the Model 314 is actually **maintained, without degradation,** over the wide ranges of frequency variation, voltage/current level, and harmonic content for which the instrument is rated. Furthermore, the direct-reading **digital** presentation of phase, to four-place resolution (0.1° increments) requires no interpretation or interpolation, and is not subject to reading errors or parallax. **The phase angle you see is the phase angle that exists — to within ±0.5°,** without correction or uncertainty.

SPECIFICATIONS

ELECTRICAL

Range: 000.0° to 360.0°, Direct-reading
Frequency Range: 47-53, 57-63 Hz (specify at time of ordering)
Input Current Range: (both input circuits) .015-50 A rms
Input Voltage Range: (both input circuits) 0.3 to 600 V rms
Current-Input Impedance: Approx. 2 or 20 milliohms
Display: Four digits, non-flickering, 0.6″ numerals
Resolution: 0.1°
Accuracy: ±0.5°
Burden:
Voltage: 1.8 VA max. at 600 V rms input
Current: Approx. 2.5 VA at 50 A rms input
Interaction Between Inputs: None
Errors Due to Harmonic Distortion: None for harmonic distortion up to 30%, any harmonic
Errors Due to Offground Inputs or Reversal: None
Overload:
Voltage: 100% overload for 1 minute
Current: 100 A rms for 1 minute
Dielectric Test: Up to 2200 Volts rms between inputs and ground (ANSI-C39.5)
Self-Check: Provided for 000.0°. Full scale (360.0°) is autocalibrated internally
Power Required: 115/230 V, 50-60 Hz, 20 Watts

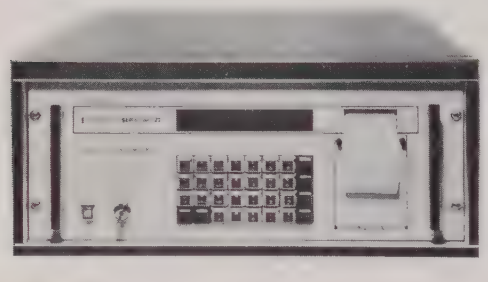
MECHANICAL AND ENVIRONMENTAL

Size: Portable, weatherproof carrying case with cover 11″ L x 7″ W x 9½″ D; without cover 11″ L x 7″ W x 7″ D (Panel 11″ x 7″); shipping 11″ x 14″ x 18″.
MR16-1 Rack Mount (optional): 19″ rack plate and dust cover.
Operating Temperature Range: 10°F to 110°F.
Weight: 10 lbs. (5 kg.); shipping 17 lbs. (8 kg.).

FOR FULL INFORMATION AND DETAILED SPECIFICATIONS WRITE FOR BULLETIN 314

DRANETZ

SER SYSTEM 22
SEQUENCE OF EVENTS RECORDER



Ruggedly built for the power industry. Documents the activity of relays in substations, power generating stations, or industrial process control systems. Each input circuit senses a contact opening or closure. When such an event occurs, the time, state (alarm or normal), input number, and a user programmed alpha input description are printed. This data may be transmitted to a remote printer, supervisory control, or CRT via the recorder's RS232C interface.

The following printout is typical of information that is recorded immediately after a relay state change is detected.

Time of trip HRS:MIN: SEC:MSEC	Current Status	Input #	Alphanumeric Description of Input
17:02:45:020	ALARM	0107	OC RELAY LINE 2
	ALARM	0050	DIST RELAY LINE 4
17:02:45:021	NORM	0711	BREAKER #1 LINE 1

APPLICATIONS

- Aids in diagnosing system faults
- Pinpoints malfunctioning equipment in substations or power generating stations
- Portable unit allows the sequence testing of newly installed relay systems
- Provides operating personnel with an instantaneous indication of changes in system status

FEATURES

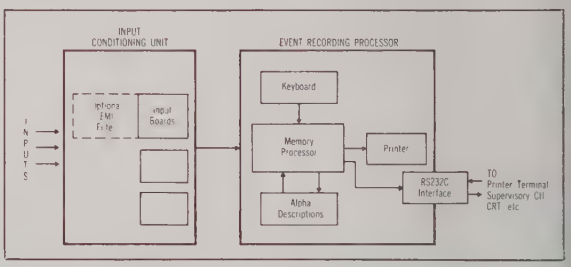
- 1 msec resolution • 32-1024 input capability
- Ongoing self-diagnostics — detailed diagnostic output
- Modular design • High noise immunity
- Instantly programmable solid state alpha description memory
- Portable or permanent installation
- Remote programmability
- RS232 interface permits transmission of output to remote printer, supervisory control, CRT, or annunciator

SYSTEM CONFIGURATION

The single panel Event Processor/Terminal (7" H x 19" W x 22" D) contains the processor, event and input description memory, power supplies and up to 32 input points. With the integral printer and keyboard-display option,you truly have a portable sequence of events recorder.

The system may be expanded through the addition of Input Conditioning Units (7" H x 19" W x 22" D) containing up to 64 inputs per panel (8 inputs/board with 8 boards/panel). A fully expanded system includes 16 additional input panels, for a total of 1024 inputs.

Two printer options are available. Model 2210PT incorporates an integral printer keyboard-display package. Model 2210P utilizes a separate terminal.



SPECIFICATION SUMMARY

System Power — 120 VAC primary power source. Automatic bumpless transfer to 125 VDC standard to insure continuous operation.

Inputs — Dry contact either normally open or normally closed programmable on a point by point basis. 1024 inputs maximum.

Input Boards — Input boards accept 8 inputs. Each input circuit provides optical coupling and analog/digital filtering of the input signal, 8 input boards plug into a 19" Input Conditioning Unit. Input boards are available for field contact voltages in the following ranges: 10-24 VDC, 40-90 VDC, 85-125 VDC, and 120-155 VDC.

Field Contact Voltage — Power may be supplied by the system's own optional power supply or by a user source such as the user's station batteries.

Resolution — 1 millisecond for up to 512 inputs and 2 milliseconds for up to 1024 inputs. For a 512 input system, events occurring more than 1 millisecond apart will be listed in the order in which they occurred with their event time to the millisecond. Events that occur within a millisecond duration will be considered to have occurred simultaneously.

Contact Bounce — 4, 8, 16, 32, 128, and 256 millisecond delays are available to eliminate multiple printouts due to contact bouncing. Delays are field selectable using a single jumper for the entire system.

Clock — Phase locked to line frequency with automatic transfer to crystal oscillator when voltage drops below 100 volts. Will synchronize to external pulse such as WWV. Pulse will be suppressed when events are in memory in order not to disturb the relative time differences between events in memory and events which may be occurring. If the unit contains the front panel printer, keyboard, and display, time will be continuously shown on the display unless the unit is being programmed.

Printer — Two standard printers are available, a free standing Dot Matrix Printer. and a thermal printer keyboard display combination located on the front of the Event Processor/Terminal. Printers are operative only when event information is being printed. A message is printed when paper is low. Return to normal messages may be suppressed. An inhibit print function allows events to be processed and retained in memory while paper is being replaced or printer is being repaired.

Event Memory — At least 113 levels of event memory is standard, expandable to 339 levels. This is a "worst case" value based upon one input per board changing state. Multiple inputs changing state on the same board within the same millisecond will use only one level of memory.

Alphanumeric Input Descriptions — 8, 16, 32 character alpha descriptions are available. Descriptions are stored on boards containing non-volatile, electrically alterable read only memory chips. Alpha capability may be added or expanded in the field. If the recorder is to be moved between two stations, a separate alpha description board can be programmed and plugged in when needed. Descriptions are input through the printer keyboard in an interactive mode with the recorder's processor. In the event the alpha board is inoperative, the numeric event data will still be printed.

Noise Immunity — Extensive analog and digital filtering, and shielding have been designed into both the Event Processor and Input Conditioning Units to attenuate conducted and radiated noise. An optional EMI filter board connected to the front end of an input board may be used in extra-ordinary high noise environments.

System Diagnostics — Ongoing self-diagnostics. The unit tests the majority of its hardware on an ongoing basis. Should a malfunctioning component be found, a descriptive message will be displayed and in some cases, the unit will take corrective action (i.e., if a defective input board is downgrading the performance of the system, it will be internally disconnected).

An optional ground fault detector — Trips on 5 mA to ground on either side of the power supply. An optional bank of switches isolates inputs, in groups of 32, to aid in determining which input is causing the ground fault.

Single point test — The state of a designated input is changed, forcing the system to process an event. If the system finds it cannot process the event properly, a message is printed. This test may be programmed to occur hourly, daily, or may be initiated manually.

24 hour printout — At midnight, the system will update the time and date and print out a summary of inputs that are currently in alarm.

DRANETZ

SERIES 606*

POWER LINE DISTURBANCE ANALYZER/RECORDER

- For 115/230/460 V rms, 1 and 3 phase systems.
- Monitors, classifies, times and prints out line disturbances.
- Immediate and day-end printouts.
- Operates on command or disturbance — no wasted paper.
- For portable or permanent installation.
- 4 hour internal carry over power.

The 606 is designed specifically for monitoring power lines connected to computers, process control systems, hospital equipment and data communications devices, which are particularly susceptible to line transients, level changes or other disturbances. Using a digital microprocessor, the 606 classifies each disturbance into IMPULSE, CYCLE-TO-CYCLE CHANGE or SLOW RMS CHANGE. When preset thresholds are exceeded, the instrument prints out time, classification, magnitude, duration and channel designation. Data is also accumulated for overflow and day-end printout. The instrument is designed for unattended monitoring in a permanent installation or for temporary use at more than one site.

SPECIFICATIONS

Input Voltage Ranges: 115, 230, 460 V rms ±50%, all transformer isolated, Zin > 100 kΩ

Number of Inputs: Model 606-1, 1 input; Model 606-3, 3 inputs (3φ or separate circuits)

Test Modes:

AVG+ or AVG−: Increase or decrease in steady state rms, averaged over 10 sec

SURGE or SAG: Increase or decrease in cycle-to-cycle rms value

IMPULSE: 0-peak value of impulse (excluding line voltage waveform) having duration 0.5-800 μsec. Optional Adaptors (see below) measure strength, polarity and direction.

ACCUMULATED COUNT: Summation of disturbance data in memory (includes time, HI AVERAGE, LO AVERAGE, HI SURGE and number of HITS, LO SAG and number of HITS, HI IMPULSE and number of HITS)

Printing Modes:

AVG+ or AVG−: Prints time, AVG+ or AVG−, rms VALUE, CHAN., when exceeding threshold of 3, 5, 10, 15 V rms*

SURGE or SAG: Prints time, SURGE or SAG, rms VALUE, CHAN. and duration (cycles) when exceeding threshold of 3, 5, 10, 15 V rms*

IMPULSE: Prints time, IMPULSE, 0-pk VALUE (excluding line voltage) and CHAN, when exceeding 0-pk threshold of 50, 100, 200, 400 V. See below for additional information printed when Impulse Analysis Adaptors are used.

SUPPLY DOWN or UP: Prints POWER OFF or POWER ON and TIME

STORED DISTURBANCES: Stores data on disturbances during printing. Prints out when printer clears

ACCUMULATED COUNT (Short Term): Overflow of data entering printer. Prints out automatically

DAILY ACCUMULATED COUNT: End-of-day print out. Prints number of day and ACCUMULATED COUNT

TEST: Prints time and ACCUMULATED COUNT

RESET: Prints time and ACCUMULATED COUNT, resets memory

PRINT OFF: Prints PRINT OFF and TIME, disables printer, all data goes into accumulator for delayed summary printout

Accuracy:

AVG+ or AVG−: At 60 Hz (sine wave signal), ±1% of reading ±1% of nominal input

SURGE or SAG: At 60 Hz (sine wave signal), ±1% of reading ±1% of nominal input

IMPULSE: ±5% of reading ±1% of maximum impulse calibrated with a positive going, 10 μsec, half sinewave impulse. 6 dB bandwidth with half sinewave impulses: 800 μsec to 0.5 μsec

Clock: Indicates real time in hours, minutes, seconds, crystal controlled. During power off, operates on internal batteries (4 hours). Clock resets from front panel buttons

Printer: 18 character, alpha-numeric, thermal, paper 2¼″ wide, prints 1 line/sec

Supply Power: 90 to 140 V rms, 45-450 Hz, 1φ, 1.0 A maximum (also DC operation 120-170 V maximum).

Case: Portable, removable cover with carrying handle.

Size (with cover): 11″ H x 7″ W x 9½″ D; shipping 11″ x 14″ x 18″.

Weight: 16 lbs. (7 kg.); shipping 24 lbs. (11 kg.).

Options: Opt. 101 (606-3 only), freq. disturbances; Opt. 102, 115/230 V supply power (switch selectable), 45-65 Hz; Opt. 103 (606-3, Opt. 101 only), monitors 400 Hz power lines; Opt. 104, external event indication; Opt. 105, enables use of Impulse Analysis Adaptors; MR15 Rack Mount Series, 19″ rack plate and dust cover.

Model K103 Test Kit: Includes disturbance generator designed to verify operation of Series 606. Also includes a card puller, an extender card, and a set of programmed memories for assisting in calibration and troubleshooting.

Model 910 Uninterruptible Power Supply: For complete operation of 606 during power shutdown up to 2 hours. Fully protected from impulses to 1600 Volts, sags and surges of 50%, and total power interruptions.

Input (under normal conditions): 115/230 V rms nominal (switch selectable), 45-65 Hz, 1φ, 1.0 A maximum.

Output: 120 to 170 Volts, DC, 1.0 A.

Recharging Time: 18 hours.

Size: Portable carrying case same size as 606.

Weight: 35 pounds (16 kg.).

*These values for 115 V input; multiply by x2 or x4 for 230 V rms or 460 V rms.

SERIES 606-PA-(600X)*

IMPULSE ANALYSIS ADAPTERS FOR SERIES 606

Impulse Analysis Adapters supplement the analytical capabilities of the Series 606 Power Line Disturbance Analyzers by providing recorded measurements of **impulse strength,** i.e., the integral of impulse voltage with respect to time. The **strength** indicates the potential of the disturbance to damage or interfere with **sensitive** electronic equipment. Two of the four models in the Series also provide indication of the Polarity and Direction, i.e., from source to load or vice versa. These data are conveyed to the associated Model 606 (equipped with Option 105), for printing in conjunction with the information provided by the Model 606 itself.

* Manufactured under U.S. Pat. Nos. 3,549,874; 4,187,461; 4,206,413

SPECIFICATIONS

Function

606-PA-6001 Single-phase, 50/60 Hz; measures Strength only.

606-PA-6002 Three-phase, 50/60 Hz; measures Strength only.

606-PA-6003 Single-phase, 50/60 Hz; measures Strength, Polarity and Direction. Includes one current probe.

606-PA-6004 Three-phase, 50/60 Hz; measures Strength, Polarity and Direction. Includes three current probes.

Printed Information

Strength: Separates IMPULSE disturbances into six ranges of Strength. Prints appropriate range, i.e., >.001 V-SEC.

Polarity: Prints + or −.

Direction: Prints SRCE or LOAD.

Input Voltage Ranges: Same as Series 606.

Input Current Ranges: (Only applies to -6003 and -6004).

Max. at power-line frequency (47-63 Hz): 100 A. rms

Max. Impulse: 1000 A. Peak at 1 msec

Min. for Direction determination: 1 A. for at least 0.2 μsec

Current Probe Insertion Impedance: 0.4 mΩ at 60 Hz.

Steady State Power Requirements: Single-phase Adapters operate from power supply of associated Model 606. Three-phase Adaptors contain a separate power supply which requires 90 to 140 Vrms, 45 to 65 Hz, 1φ, at 0.25 A. nominal.

Option 102: Available on -6002 and -6004 to permit operation from 180 to 280 Vrms, or 90 to 140 Vrms (switch-selectable), 45-65 Hz, 1φ.

FOR FULL INFORMATION WRITE FOR BULLETIN 606

DRANETZ

SERIES 616*

DC/AC VOLTAGE DISTURBANCE ANALYZER

- Field troubleshooting
- Power supply analysis and testing
- Testing power conditioning equipment
- Monitoring battery voltages
- Simultaneous monitoring of AC and DC voltages

The Series 616 is a highly portable easy-to-connect analyzer for recording voltage disturbances on three channels: one AC and two DC. The Series 616 combines the outstanding features and operating techniques of the Series 606 (described on previous page) to record IMPULSES, SAGS and SURGES, and SLOW AVERAGE variations, when they occur, in an easy-to-interpret alphanumeric printout. The instrument is ideal for pinpointing the effects of AC input line disturbances on the DC outputs of power supplies in computers, communication equipment, and medical apparatus. Two models, the Model 616A for 4 to 25 VDC and the Model 616B for 8 to 50 VDC, are available.

* Manufactured under U.S. Pat. Nos. 3,549,874; 4,187,461; 4,206,413

SPECIFICATIONS

Input Voltage Ranges:* Channel A, 40 to 250 Vrms, 45 to 65 Hz; Channels B&C, ±4 to 25 VDC.

Test Modes

Impulse: Peak voltage of impulse after removing steady-state AC or DC voltage level. Impulse durations range from 0.5 to 800 μsec.

Sag/Surge: Sudden changes in steady-state voltage. Measurement interval equals one cycle of Channel A signal.

Slow Average: Slow changes in steady-state voltage. Measurement time constant is approximately 5 seconds.

Accumulated Count: Summation of disturbance data in memory (includes the number and worst case values of each type of disturbance on each channel since the beginning of the day).

Printing Modes

Impulse: Prints time, IMPULSE, 0-pk. value (excluding steady-state) and channel, when exceeding 0-pk. thresholds of 0.5, 1.0, 2.0 and 4.0 V* for DC channels, and thresholds of 50, 100, 200, 400 V* for AC channel.

Sag/Surge: Prints time, SURGE or SAG, voltage, duration (cycles) and channel when exceeding thresholds of 0.3, 0.5, 1.0, 1.5 V* for DC channels, and thresholds of 3, 5, 10, 15 Vrms* for AC channels.

Slow Average: Prints time, AVG+ or AVG−, voltage, and channel when exceeding thresholds of 0.3, 0.5, 1.0, 1.5 V* for DC channels, and thresholds of 3, 5, 10, 15 Vrms* for AC channel.

Supply Power: 90 to 140 Vrms, 45 to 65 Hz, 1φ, 1.0 A. maximum (also DC operation from 120 to 170 V).

Options: Opt. 101, frequency disturbances on channel A; Opt. 102, 115/230 V supply power (switch-selectable), 45 to 65 Hz; Opt. 104, external event indication; MR15 Rack Mount Series, 19″ rack plate and dust cover.

Model 604A-PA-1001: Adapts the Model K103 (described on previous page) for troubleshooting and calibration of the Series 616.

*These values are for Model 616A. Multiply by 2 for Model 616B.

FOR FULL INFORMATION WRITE FOR BULLETIN 616

MODEL 3100

SAMPLING NETWORK ANALYZER

FEATURES

- Measures Complex V, I, Ratio, Phase Angle and Power.
- Computes all Parameters Individually to 14th Harmonic.
- 1 Hz to 500 kHz.
- 1 mV to 300V Full Scale Ranges.
- Computes Magnitude/Phase or Real/Imaginary (Quadrature).
- High Accuracy: ±0.05% F.S., ±0.05% R, ±0.03°.
- Acquisition Time Down to One Cycle.
- Dual Channel with Auto-Ranging.
- RS-232C Interface Standard.
- IEEE-488 Bus Interface Available.

APPLICATIONS

Applications for the 3100 will be found where high precision phase, power and ratio measurements in the presence of high harmonic content, are common. The wide 70 dB dynamic range of the instrument, plus the high level of stability and reliability with state-of-the-art accuracy, make the 3100 truly unique in the network measurement world.

Aircraft, aerospace, and electronics applications are numerous. The 3100 provides a new accuracy dimension for ATE and GSE consoles, test set-ups for analog board testing, module and subsystem testing, vibration analyzers, and circuit and network analysis:

- Ground Support and Equipment Test
- Precision Power & Harmonics Analysis Measurements
- Vibration Analysis
- Communications Network Testing
- Sonar Pulse Testing
- AC Coupled Transfer Function Analysis
- Servo and Synchro Measurements
- R L C Measurements
- Line Fault Analysis
- ATE Consoles
- Filter Tests
- Amplifier Tests
- Oscillator and Crystal Testing

FOR FULL INFORMATION WRITE FOR BULLETIN 3100

DRANETZ
ENGINEERING LABORATORIES INCORPORATED
1000 NEW DURHAM ROAD, CN-91, EDISON, NEW JERSEY 08818 • (201) 287-3680 • TWX: 710-997-9553

FREE TECHNICAL ARTICLES

Prepared by the Engineering Department of Dranetz Engineering Laboratories

TD-305C/110	Interface Bus Adapter Opt 110 for 305C Phasemeter (2-page technical paper).
TM-102081	Measurement of Power Factor in Single-Phase and Three-Phase Systems Using Phasemeter Techniques (17-page technical paper).
TM-102991	When & How to Automate Phase Instrumentation (12-page technical paper).
TP-102980	Phasemeter Specs Can Fool You (6-page reprint from **Electronic Design,** November 22, 1975).
TP-102984	Applications Handbook of Precision Phase Measurement (28-page publication).
TP-102985	Advantages of Phase-Angle Measurement by Digital Techniques (7-page technical paper).
TP-102988-AR	Tracking Down & Identifying Power Line Aberrations (4-page reprint from **Mini-Micro Systems,** July 1976).
TP-102998-TA	Input-Output Disturbance Analysis — A New Technique for Power-Supply Performance Evaluation (6-page technical paper presented at Powercon 4, May 13, 1977).
TP-102999	The Power Problem — A 2-page reprint from **Computer Security** (Newsletter for Computer Professionals). July/August 1979. By Stephen J. Tharp, Dranetz Engineering Laboratories, Inc. and Aileen MacGahan, Chase Manhattan Bank.
TP-103901-AR	Sequence of Events Recorder Monitors Turbo-Compressors (1-page reprint from **Oil, Gas & Petrochem Equipment,** October 1980).
TP-103905-TA	Impulse Strength Measurements: A New Technique For Analyzing Power-Supply Performance Under Actual Field Conditions. Presentation to: International Telecommunications Energy Conference, November 27, 1979. Given by: Stephen J. Tharp and Philip Cox, Dranetz Engineering Laboratories, Inc.
TP-103913-AR	Evaluating Power Line and Power Supply Performance in Computer Systems (6-page reprint from **Digital Design,** February 1980).
TP-103916-AR	Hospital Cures Power Problems, Ends Glitches (1-page reprint from **Computerworld,** June 15, 1981).
TP-103921-AR	SERs Move Into Industry (4-page reprint from **Control Engineering,** October 1981).
AR-108001	Phase Meters — Applications From the Lab to the Stars (6-page reprint from **Electronics Test,** August 1979).
AR-108004	Sequence-of-Events Recorders Pinpoint T-line Fault Causes (4-page reprint from **Electric Light & Power,** February 1980).

THESE ARTICLES ARE AVAILABLE UPON REQUEST

STATEMENT OF WARRANTY

All products of Dranetz Engineering Laboratories, Inc. are warranteed to the original purchaser against defective material and workmanship for a period of one year from the date of delivery. Dranetz will repair or replace, at its option, all defective equipment returned to it, freight prepaid, during the warranty period, without charge, provided there is no evidence that the equipment has been mishandled or abused.

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CONTROL № 2806-2

TM 103140 VOLUME 1

APPLICATION TO BECOME A REGISTERED RECIPIENT OF A DRANETZ ENGINEERING LABORATORIES PROPRIETARY MANUAL.

1. The undersigned company wishes to obtain the loan of a maintenance manual for the below-identified equipment:

   Model No. Serial No.

   Equipment Description

2. In making this application, the undersigned agrees that upon receipt of the requested literature, the information contained therein will be used solely for the purpose of facilitating the repair of Dranetz Engineering Laboratories' equipment purchased by the recipient. The manual is serially numbered and will be registered solely to the undersigned recipient and is to be returned to Dranetz Engineering Laboratories when no longer required and in any event if ownership of the equipment changes.

3. The undersigned agrees to respect the proprietary nature of the information contained in the manual so furnished including but not limited to the obligation to maintain the information in confidence, not to disclose it to others, and not to make any copies.

4. The undersigned recognizes that the loan of the manual does not imply any license to use the information contained therein except for the limited purposes set forth in paragraph 2 above.

5. This application is a legal document binding the applicant corporation and the individual employees thereof entrusted with its possession and use.

_____ _____
Date (Print Name of Applicant Company)

BY _____
(Authorized Signature)

RETURN THIS APPLICATION TO:

Dranetz Engineering Laboratories, Inc.
ATTENTION: Customer Service Dept.
1000 New Durham Road, CN-91
Edison, New Jersey 08818

_____
(Print Name)

Dept. _____

St. Address _____

City _____ State _____ Zip _____

President's "E" Award

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MA22631